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Training and Employment of University Graduates

IF happily unemployment of graduates is less serious in Great Britain than in some other European countries, it has been sufficiently widespread to offer obstacles to the work of the Society for the Protection of Science and Learning in finding occupation for displaced men of science from abroad, apart from the existence of a by no means negligible amount of wastage and misplacement of young graduates of our own universities. Indeed, the position led the University Grants Committee in its last report to suggest that the universities themselves should consider not merely the question of the appropriate number of university students in relation to the population of the country as a whole, but also that of the appropriate number for any particular university. Granting that a university should not be too preoccupied with problems of purely professional vocations for its students, it should none the less face the question whether the time has arrived, or is approaching, when additions to its numbers will tend to impair the quality of the instruction and the value of the training for life it sought to give.

For these reasons, the inquiry on unemployment among graduates, and the study of the proposals for diminishing unemployment in intellectual professions, which has already been initiated by the Committee on Intellectual Co-operation of the League of Nations, is of no less interest in Great Britain than elsewhere; while W. M. Kotschnig's recent study of unemployment in the learned professions* is also a valuable contribution. The case he presents for real educational and occupational planning in our changing society as the only solution of this difficult problem deserves careful consideration, reinforced as it is from other quarters of the industrial world by the suggestion that industry should consider more closely not merely qualitative but also quantitative requirements in regard to recruitment generally.

It can scarcely be denied that neither the universities nor professional associations of scientific workers, despite serious warnings, have given anything like the attention to this question that it demands. The report on graduate employment recently issued by the National Union of Students, to which reference was made in discussions at the British Association meetings at Nottingham, brings together in this field a number of suggestions or proposals which require attention and action by professional associations as well as by university authorities.

This report, which brings out the fact that in Great Britain the question of misemployment among graduates is as important, if not more important, than that of actual unemployment, reveals the meagreness and inadequacy of existing statistics and the complete absence of planning or control over the numbers entering various branches of study, as well as the ignorance on the part of students proceeding to a university of conditions in the employment market. The most serious criticism in the report is, in fact, that of the lack of guidance and help available at the universities for placing students in careers. Even where appointment boards or officers are to be found, their organization often leaves much to be desired. Contact with students is imperfect, and with industry, commerce and the professions is often poor.

Many who have attempted to recruit university graduates, particularly for any of the less usual openings, will agree that much of this criticism is

* London: Oxford University Press, 1937. 12s. 6d. net.

well founded. It is no uncommon experience to find that after approaches to the universities appointments boards or advertisements in the appropriate scientific or technical journals have drawn blank, promising candidates have been encountered accidentally, who, like the professors of their particular faculty, were quite unaware of the existence of the vacancy. Quite apart from the fact that the outlook of graduates on the sphere of employment is often unnecessarily narrow, such experiences are common enough to indicate not merely the failure of graduates to look round them intelligently but also an amazing lack of contact between the appointments boards and the different faculties or departments the students of which it is their function to place.

There can, of course, be no question of value of the appointments board when well organized and properly run. An efficient board rapidly builds up a reputation for supplying candidates of the right type; and this is as valuable to the employer as to the graduates it places. Accordingly, the highly constructive suggestions in this matter, which are outlined in an appendix to the report referred to, merit close attention by all concerned with the placing of graduates in employment; for the establishment of efficient appointment boards must inevitably precede the consideration of the quantitative aspect of the question. These suggestions show clearly that at the present time the problem is not so much one of finding posts for graduates but of finding graduates to fill the existing vacancies.

One of the first results of a really efficient appointments organization would be not only to co-ordinate the spasmodic and often haphazard recommendations and efforts of individual professors and teachers, and to promote the supply of candidates in whom due weight was given to the other qualities besides the academic which they possess, but also to facilitate the collection of accurate and comprehensive information. The functions of the organization should, in fact, include a survey of the whole field of potential employment for university graduates, and the establishment and maintenance of contact with employers' associations, professional institutions and organizations and the like.

Information regarding the qualifications and personnel required for different careers, as well as of the nature and conditions of the work, salary scales and prospects, is frequently readily obtainable, but corresponding information regarding the overcrowding of a particular occupation, new developments and tendencies is often deficient and inaccurate, and in many places the means of making even the existing information really available to students early in their university career appear to be in need of improvement. It is suggested, accordingly, that a handbook on the lines of the "Handbook on Careers for Graduates and Students", which is published by the University of London Appointments Board, might be issued by each appointments board.

Obviously there is room in this particular field for effective co-operation between the appointments boards of different universities. Even if certain universities desired to expand the information regarding the particular occupations for which they specially prepare students, there would appear to be no reason why such a handbook should not be prepared on behalf of all the universities. Not only should a mere comprehensive handbook be obtainable in this way, but also co-operation should offer substantial financial savings.

Whether there is need for the different subcommittees suggested in the report to deal with technical appointments, teaching, professional, Government appointments and commerce, etc., may well be a matter of opinion. Much depends on obtaining men of the right type of personality, mature experience and with something of a flare for establishing contacts to serve the board. Appointments officers of the right type could probably be relied upon to take care of the requisite internal as well as external contacts, though it may sometimes be advisable for the university to institute some means of stimulating the use of the machinery provided in the boards' organizations, so as to bring together all those interested in placing graduates whether of a special faculty or not.

As to the wisdom of the further suggestions regarding contact between students, and between the appointments officers of different universities, there can scarcely be any difference of opinion, though there are other ways of securing contact with students than by representation on the boards. Such co-ordination and organization are essential if statistical information is to be collected in standardized form on the numbers of students in each faculty, the potential output of the university for different careers and the numbers of students leaving or who have left the university, and the nature and extent of unemployment among them.

Valuable, however, as are such statistics as a preliminary to planning the wiser use of university education on the community, we must guard against the mistake of allowing the university authorities or the students themselves to be preoccupied excessively with the professional prospects of later life. The effective employment of university graduates is a matter of much moment to the community as a whole as well as to the individuals concerned, since the appropriate use of talent to a large extent governs the pace of social progress. This is one reason for regarding with concern the comparative neglect of university graduates in the local government service of the country. None the less, we must be at pains to reconcile the objective of the best training for a vocation in life with that of the best training for life itself.

Once again, therefore, we are brought back to the question of the true purpose of a university, and even here it seems that a university appointments officer might well make a valuable contribution. His contacts with the industrial and commercial world should enable him to supply timely warning about the evils of premature or excessive specialization, and to insist on the need for men and women with a wide outlook, sense of values and cultural interests so strongly stressed in recent discussions. It should enable him too, perhaps, in his contact with students, to inspire them with a sense of responsibility for service which, by bringing out the fundamental meaning of vocation, may rob vocational training of its dangers. Nor should he lack the opportunity to give timely warnings as to the importance of cultivating human interests and utilizing to the full the opportunities which the social and athletic activities of college life afford of developing initiative, personality and the capacity to co-operate, upon which, as much as on intellectual attainment, depend alike individual success and the fullest meed of service to the community.

Growth-Regulating Substances in Plants

Phytohormones

By F. W. Went and Kenneth V. Thimann. (Experimental Biology Monographs.) Pp. xi+294. (New York: The Macmillan Co.) 17*s*. net.

THIS book will prove very valuable as it reviews admirably a field in which the contributions have recently been so numerous that it is difficult to follow them all. (The authors give references to seventy-four papers on plant hormones for 1936 alone.) This rapid output is no doubt due to the discovery by Kögl and Kostermans (*Z. physiol. Chem.*, 235, 201) in 1934 that indole-3-acetic acid, sometimes called 'heteroauxin', a substance which can be synthesized, acts on plant growth in very nearly the same way as the natural growth-hormone or 'auxin': for this has provided wonderful opportunities for experimenting. But unfortunately, as the authors point out, the quality of some of this recent work has not been so good as that of the earlier work on the growth-hormone: indeed, some recent contributions have shown that the investigators responsible for them neither know what has been done already nor understand what are the problems at issue. The book should, therefore, be very useful, since it reviews critically the subject of the hormones of higher plants and shows up the main problems clearly: indeed it is one of the chief attractions of the book that it looks to the future as much as to the past. The authors include also summary statements of many interesting unpublished results, and although an excellent historical survey of the same field by Boysen Jensen entitled "Die Wuchsstofftheorie" appeared in 1935, progress has been so rapid that they have been able to include a great deal that was not in the earlier book.

Boysen Jensen has claimed ("Die Wuchsstofftheorie", p. 12) that in his well-known experiments of 1910, 1911 and 1913, from which the modern study of the growth-hormone has mainly developed, he proved that there exists a growth-promoting substance in the oat coleoptile during the phototropic excitation, and that it is by the movement of this substance that the phototropic stimulus can be transmitted (as he showed) from the tip across a watery gap below. In the reviewer's opinion, this claim is justified, except that, as Went and Thimann point out, he did not show that he was dealing with a single growth-promoting substance rather than with several substances. But neither did the later experiments of Paál (*Ber. bot. Ges.*, 32, 499; 1914; *Jahrb. wiss. Bot.*, 58, 406; 1919) show that the growth-hormone is a single substance, in spite of what Went and Thimann say (p. 11). The important point which was missed by Boysen Jensen but established by Paál and by Söding (*Ber. bot. Ges.*, 41, 396; 1923) is that

even the tips of *unstimulated* coleoptiles form growth-promoting substance (or substances), and it was not generally agreed that it is a single growth-substance which they form, until this substance, now called 'auxin', was extracted and studied by Went himself (*Rec. trav. bot. Néerl.*, 25, 1; 1928). Later work has shown that this auxin is the same growth-substance which was demonstrated by Boysen Jensen, and it has been found that auxin regulates a surprising number of other growth processes also.

The authors are a little misleading in saying that Dostál (*Acta Soc. Sci. Nat. Moravicae*, 3, 83; 1926) interpreted his experiments on the correlative inhibition of axillary buds "in terms of nutrition and water relations, like his predecessors": for this gives the impression that he interpreted them in terms of a withdrawal of nutriment or water. But actually he attributed the inhibition to an effect upon the buds of metabolic products coming *from* the leaves, an opinion not very different from the recent discovery that it is the auxin secreted by the young leaves which somehow brings about the inhibition of axillary buds.

The investigations reviewed in this book have progressed quite along the lines advocated by Roux for animal embryology. First came the recognition of various 'complex components' in plant growth, and the discoveries that they depended on transmitted influences of unknown nature; among such 'complex components' were the growth-reactions of the tropisms, the initiation of cambial growth and of root-formation, and the promotion of the growth of coleoptiles and shoots. Next came the evidence that the influences on which these processes depended could cross watery gaps and were due to the movements of a soluble substance or substances. Later again came the extraction of the substance concerned and its identification as auxin. The next step must be to discover more in detail the manner in which the auxin acts, and thus to continue the analysis in the hope of reaching finally the basic molecular or ionic reactions. But when, or if, these are discovered, a knowledge of the foregoing analysis will still be necessary for anyone who wishes to understand plant growth.

R. SNOW.

West African Plant Lore and Uses

The Useful Plants of West Tropical Africa

By Dr. J. M. Dalziel. Being an Appendix to the "Flora of West Tropical Africa" by J. Hutchinson and J. M. Dalziel. (Published under the authority of the Secretary of State for the Colonies.) Pp. xii + 612. (London: The Crown Agents for the Colonies, 1937.) 18*s*.

THE series of Colonial floras issued from the Royal Botanic Gardens, Kew, are highly technical works of great value to the systematic botanist and to the trained worker in the countries in question. But there is much information of economic and human interest which lack of precise information and consideration of space has perforce to be omitted. Dr. Dalziel's volume is an attempt to fill this gap in our knowledge of the West African flora as a supplement to the "Flora of West Tropical Africa" recently completed by Dr. Hutchinson and himself.

Dr. Dalziel was especially well qualified for the task. His long service as a medical man in the British West African Colonies, his knowledge of the flora and his interest in native customs and languages—he is the author of "A Hausa Botanical Vocabulary"—have yielded a mass of information collected personally. This has been supplemented from notes on herbarium specimens and from literature, especially the published work of Dr. A. Chevalier and his colleagues on French West Africa, which covers the greater part of the area dealt with.

Care has been exercised in the selection of vernacular names, which are notoriously difficult to collate with certainty. These are classified geographically and according to local dialects, and though in some cases open to revision may, as the author points out, become important where a Colonial administration seeks to fix official names for commercial timbers or noxious weeds.

Obvious characters of the species included are described as well as their domestic, medicinal and commercial uses, but it is assumed that the volume will be used in conjunction with the "Flora", the arrangement of which it follows as regards the families, under which genera and species are arranged alphabetically. The numerous references to relevant literature in the text are supplemented by a general bibliography which is additional to that included in volume 1 of the "Flora".

A detailed index of the vernacular names covers forty-three closely printed pages, and there are also indexes of common English and scientific names.

Dr. Dalziel's volume is an invaluable contribution not only to our knowledge of the economic botany of West Africa but also to its ethnology.

A. B. R.

Recent Developments in Probability Theory

(1) Généralités sur les probabilités; variables aléatoires
Par Prof. Maurice Fréchet. (Traité du calcul des probabilités et de ses applications, par Émile Borel, Tome 1: Les principes de la théorie des probabilités, Fascicule 3: Recherches théoriques modernes sur la théorie des probabilités, Livre 1.) Pp. xvi + 308. (Paris: Gauthier-Villars, 1937.) 90 francs.

(2) Théorie de l'addition des variables aléatoires
Par Prof. Paul Lévy. (Monographies des probabilités, Fascicule 1.) Pp. xvii + 332. (Paris: Gauthier-Villars, 1937.) 120 francs.

(3) Random Variables and Probability Distributions
By Prof. Harald Cramer. (Cambridge Tracts in Mathematics and Mathematical Physics, No. 36.) Pp. viii + 121. (Cambridge: At the University Press, 1937.) 6*s*. 6*d*. net.

(4) Les lois des grands nombres du calcul des probabilités
Par Prof. Louis Bachelier. Pp. vii + 38. (Paris: Gauthier-Villars, 1937.) 18 francs.

(1) PROF. FRÉCHET'S "Généralités" represents the first volume only of a treatise which, as a whole, is to form part of the very important "Traité du calcul des probabilités" edited by Prof. Borel. The present volume is chiefly dedicated to an examination of the theory of random variables which has both simplified and re-modelled the classical theory of probability.

The volume is divided into two parts, the first of which consists of a general introduction to the theory of probability and a short chapter on various extensions of the principle of total probabilities. In the second part, Prof. Fréchet considers the mean values of random variables and proceeds to an examination of the inequality of Bienayme and its generalizations. But perhaps the most interesting work is contained in sections III, IV, and V of his chapter on different methods of convergence for a series of random variables. For here, the connexion between Prof. Fréchet's brilliant work in general analysis, including the theory of abstract spaces for which he is justly famous, and his contributions to probability theory, is clearly exhibited. In these sections of Chapter v, Prof. Fréchet considers all those random variables x which are definable in a given category of tests as the same number of points in a certain abstract space. He then proceeds to examine the various definitions of the limit of a series of random variables, to find that each of them completes the definition of a 'space' containing such random variables, and that the spaces thus defined are not identical. The whole work shows the close connexion of these developments with the order of ideas dominating general analysis.

(2) Prof. Paul Lévy's book is the first of a series of monographs destined to supplement the "Traité" of which Prof. Fréchet's work forms a part. Prof. Lévy is the author of an earlier work on the calculus of probabilities, and in this monograph he includes original work of his own as well as a survey of the most important problems and their solutions, where these have been forthcoming. He observes that, during the last fifteen years, research in the calculus of probabilities has made tremendous advances, and that problems born of the theory of probabilities of denumerable order have been discovered, for which, in a number of cases, solutions have been found. His own work during recent years has been principally concerned with the study of asymptotic problems relative to probabilities, a branch which owes much to the work of Kolmogoroff and Khintchine, who are also responsible for the fundamental results obtained from the study of series of which the terms are independent random variables. The latter are examined in Chapter vi of the present volume. Prof. Lévy further attributes to the work of Khintchine and his pupils the completion of his own study of integrals, the elements of which are independent random variables.

After a short general exposition of the foundations of the calculus of probabilities, Prof. Lévy devotes two further introductory chapters of a mathematical character to the examination of the theory of random variables and the law of probability, in close connexion with the theories of measurement and the Lebesque-Stieltjes integral. Throughout the whole work, Prof. Lévy is really concerned with the translation of the theorems of general analysis into the language of probability. He advocates practice in this exercise, so that the enunciation of a theorem in one language should automatically evoke the parallel enunciation in the other.

(3) Prof. Cramer's little book published in English as a Cambridge Tract has many points of contact with Prof. Lévy's larger work. He treats the subject, mathematically, as a branch of the theory of completely additive set functions and thus chooses his axiomatic foundations in agreement with those of Kolmogoroff. For the most part, Prof. Cramer avails himself of the method of

characteristic functions, a method which Prof. Lévy had once hoped to be able to reject in favour of the utilization, wherever possible, of more elementary arguments. Although he is apparently still of the opinion that it may some day be possible to dispense with this method, Prof. Lévy considers that for the advanced part of the theory, a familiarity with Fourier transformations and the properties of characteristic functions is essential.

Although in Part II of this brochure Prof. Cramer shows how many of the results for distributions in a one-dimensional space R_1 can be extended to spaces of any number of (finite) dimensions, he is unable here, for lack of space, to consider probability distributions in spaces of an infinite number of dimensions. This is naturally a restriction in the proper treatment of modes of 'convergence in probability'. Again, in the advanced part of the theory, Prof. Cramer finds it expedient to confine himself to the treatment of problems connected with the central limit theorem for sums of independent variables.

(4) Prof. Bachelier's brochure on the laws of large numbers has for its object the study of these laws in a more complete form than has been usual in the majority of treatises, in which they have been considered only in the simplest cases. In Prof. Bachelier's own larger work on the calculus of probabilities, these laws were treated as consequences of a more general theory, but here he deems it useful to isolate them from all analytical apparatus.

One of the principles of the more general theory to which he alludes is the supposition of the continuity of all variables, and in particular of that variable which expresses a series of exceedingly numerous tests. By means of this assumption, this variable permits of being assimilated to time; in consequence, the transformation of the probabilities in a series of tests appears as a continuous phenomenon. The whole content of this work is rigorously exact in accordance with the hypothesis of continuity, and the main object is the application of the results to problems which are, in reality, related to discontinuous variables. A. v. Z.

Practice and Principles

Belief and Action:
an Everyday Philosophy. By Viscount Samuel. Pp. 366. (London, New York, Toronto and Melbourne: Cassell and Co., Ltd., 1937.) 7*s.* 6*d.* net.

THIS ably and attractively written book is wholly in accord with much that has recently appeared in the columns of NATURE. For while the author is convinced that we must find "a way out from the intellectual anarchy of our time", he is equally definite as to the contribution which science can offer towards this end. Neither mysticism nor intuition, merely as such, can solve our problems; rather must both be criticized, and often corrected, by reason. This, however, involves neither "intellectual pessimism" nor crude materialism; on the contrary, "Science makes a spiritual view of the universe more tenable" and is, indeed, perfectly compatible with worship.

Still more significant is the application of this point of view to practical affairs. Although he advocates no extremist measures which may worsen the disease, Lord Samuel insists that economic injustice is widespread and destructive. But machinery is not the cause of this; for man's slavery to the merely material aspects of life could be removed by its further expansion, were this but properly directed, though this ideal involves "testing the very foundations on which civilization rests". But here again "history must be handled scientifically", exactly as with politics, economic and eugenics.

Discussion of more abstract themes has wisely been relegated to appendixes dealing with reality and value, matter and mind, causation, indeterminism and freedom. The treatment of the implications of the uncertainty principle is exceptionally clear; Viscount Samuel follows Planck, Einstein and Rutherford in their rejection of indeterminism, inherent in Nature, as distinct from that which is but the inevitable result of limited knowledge. This is no purely theoretical question; if "at the heart of Nature hazard rules", then all large-scale planning may prove quite futile.

Such a determinism, still further, forms the only reliable basis for any sound ethics. Well-being is indissolubly linked with good; pain and penalty with evil. But equally essential to morality are genuine choice and personal freedom, attainable only when the individual becomes a cause and is therefore determined, no longer from without, but more and more from within himself.

The presentation of purely scientific issues is neither too technical for the general reader nor too simple for the professional. The author's advocacy of the expansion of the League of Nations from a judiciary to a legislature is more controversial. It merits, nevertheless, serious consideration, while there must be few who would refuse to endorse Lord Samuel's vigorous indictment of militarist philosophy. J. E. T.

The Physiological Basis of Medical Practice
a University of Toronto Text in Applied Physiology. By Prof. Charles Herbert Best and Prof. Norman Burke Taylor. Pp. xxi+1684. (London: Baillière, Tindall and Cox, 1937.) 45*s*.

MEDICINE and physiology owe much to one another and neither can advance far without the other. Many of the greatest physicians have been physiologists as well and have spent years of their lives on physiological problems, but of recent years, and particularly in Great Britain, a generation of physicians has grown up with no real training in scientific research.

A gap has no doubt formed between medicine and physiology, and the new book by Best and Taylor will help to fill it. The authors are both physiologists, and they believe that physiology is a science in its own right, but that it is the duty of those who teach it to medical students to emphasize those facts which are most clearly relevant to medical practice. The book covers the whole field of physiology with particular emphasis on human physiology, and without much physics or mathematics. In each section, the anatomy is discussed first, then the physiology, and then the applications in medicine. Pathological conditions such as nephritis, bronchiectasis, the leucæmias, Ménière's syndrome, syringomyelia and epilepsy are discussed from the physiological point of view. The discoveries of clinical science are more fully and sympathetically discussed than in previous volumes of this kind.

It might have been supposed that two authors who had set out to cover so wide a field would necessarily have acquired much of their information at third hand. The present book bears much evidence that its authors have not been content to put forward generally accepted conclusions without full consideration of the experimental evidence. The book is not a rehash of *Physiological Reviews*. In spite of much diligent reading, few errors have been noticed.

The chief defect of the book lies in the arrangement of the references, which are collected together at the end of the book, but grouped under chapters. Seekers after references must first discover what chapter they are reading, and then hunt through a lot of pages, many of which contain no indication of the number of the chapter to which they refer. J. H. G.

Gmelins Handbuch der anorganischen Chemie
Achte Auflage. Herausgegeben von der Deutschen Chemischen Gesellschaft. (1) System-Nummer 22: Kalium. Lief. 1: Element, Verbindungen bis Kalium und Sauerstoff. Pp. 246. 28.50 gold marks. (2) Lief. 2: Verbindungen bis Kalium and Chlor. Pp. 247–514. 3.50 gold marks. (Berlin: Verlag Chemie, G.m.b.H., 1936 and 1937.)

IN the volume on potassium considerable space is devoted to a discussion of the geological origin, distribution and character of the European potash deposits, with maps and a geological section reproduced from E. Fulda's book "Das Kali". The only compounds included in this part are those with hydrogen and oxygen.

The second part of the volume on potassium includes compounds containing the elements nitrogen, fluorine and chlorine. There is a general survey of the conditions which lead to the natural formation of potassium nitrate, the preparation of which from Chile saltpetre is relatively unimportant nowadays, since it has been largely replaced by other salts in the manufacture of explosives; but its properties are fully recorded. The peculiar behaviour of the system potassium fluoride – hydrogen fluoride is illustrated by a phase rule diagram which indicates the existence of no fewer than five complex compounds.

A very useful feature of this part is the compilation of references to the enormous mass of data about the physical properties of potassium chloride in the crystalline state and in aqueous solution. Thus numerous attempts have been made to link up the classical views of Arrhenius on electrolytic dissociation with the modern ideas of Debye. The technical production of this salt is being described in a later part. References to original memoirs and patent specifications relating to the manufacture of potassium chlorate by electrolysis of solutions of the chloride are very numerous. On the other hand, the electrolytic production of the perchlorate is rendered difficult by the low solubility of this salt, which leads to incrustation of the anodes, so that in practice it has generally to be made from the sodium salt.

Mathematische Methoden der Biologie:
insbesondere der Vererbungslehre und der Rassenforschung. Von Dr. Friedrich Ringleb. Pp. vii + 181. (Leipzig und Berlin: B. G. Teubner, 1937.) 8.80 gold marks.

THIS is essentially another text-book on elementary statistical methods written to assist scientific workers with a limited mathematical background to gain an understanding of the nature and usefulness of tools they are finding it necessary to use. A special group of workers is aimed at, as is indicated by the title; the plentiful illustrations are drawn from biological and botanical material and considerable space is given to the elementary algebraic description of the workings of Mendel's law and some of the simpler applications of the theory of probability to it.

The selection of topics is from definitely classical material, and it is to be hoped that readers of this book will also become acquainted with others at the same mathematical level which give an account of the present resources statistical methods offer. The exposition is good and the examples are clearly explained. Though sampling and correlation are treated in almost too brief and antiquated a fashion in view of the developments of the last twenty years, the author has done on the whole a good job within the limits of his material.

A few slips were noted. Thus we find it stated without qualification that $m(xy) = m(x)m(y)$ and that $\sigma^2(x+y) = \sigma^2(x) + \sigma^2(y)$. Hardy's summation method is attributed to H. Günther. Class marks for distributions of continuous variables are incorrectly located, and the derivation of the Poisson law will confuse the student. CECIL C. CRAIG.

Transmutation of Matter

[Shortly before his death on October 19 last year, Lord Rutherford completed the presidential address which he proposed to deliver at the meeting of the Indian Science Congress Association on January 3–9. The latter part of the address is here reproduced and represents Lord Rutherford's last pronouncement on a subject with which his name will always be associated. Other matters discussed by him in the address were referred to in last week's leading article.—Editor, NATURE.]

TOWARDS the close of the nineteenth century, when it seemed certain that the atoms of the elements were unchangeable by the forces then at our command, a discovery was made which has revolutionized our conception of the nature and relations of the elements. I refer to the discovery in 1896 of the radioactivity of the two heaviest elements, uranium and thorium. It was soon made clear that this radioactivity is a sign that the atoms of these elements are undergoing spontaneous transmutation. At any moment, a small fraction of the atoms concerned become unstable and break up with explosive violence, hurling out either a charged atom of helium, known as an α-particle, or a swift electron of light mass called a β-particle. As a result of these explosions, a new radioactive element is formed, and the process of transmutation once started continues through a number of stages. Each of the radioactive elements formed in this way breaks up according to a simple universal law but at very different rates. In a surprisingly short time, these successive transformations were disentangled and more than thirty new types of elements brought to light, while the simple chemical relations between them were soon made clear.

We had thus been given a vision of a new and startling sub-atomic world where atoms break up spontaneously with an enormous release of energy quite uninfluenced by the most powerful agencies at our disposal. Apart from uranium and thorium and the elements derived from them, only a few other elements showed even a feeble trace of radioactivity. The great majority of our ordinary elements appeared to be permanently stable under ordinary conditions on our earth. Science was then faced with the problem whether artificial methods could be found to transmute the atoms of the ordinary elements. Before this problem could be attacked with any hope of success, it was necessary to know more of the actual constitution of atoms. This information was provided by the rise of the nuclear theory of atomic structure, which I first suggested in 1911. The essential controlling feature of all atoms was found to reside in a very minute central nucleus which carried a positive charge and contained most of the mass of the atom. A relation of unexpected simplicity was found to connect the atoms of all the elements. The ordinary properties of an atom are defined by a whole number, which represents the number of units of resultant positive charge carried by the nucleus. This varies from 1 for hydrogen to 92 for the heaviest element uranium, and, with few exceptions, all the intervening numbers correspond to known elements.

On this view of atomic structure it was evident that, to bring about the transmutation of an atom, it was necessary in some way to alter the charge or mass of the nucleus or both together. Since the nucleus of an atom must be held together by very powerful forces of some kind, this could only be effected by bringing a concentrated source of energy of some kind to bear on the individual nucleus. The most energetic projectile available at that time was the swift α-particle spontaneously ejected from radioactive substances. If a large number of α-particles were fired at random at a sheet of matter, it was to be expected that one of them must occasionally approach very closely to the nucleus of any light atom in its path. In such a close encounter, the nucleus must be violently disturbed, and possibly under favourable conditions the α-particle might actually enter the nuclear structure.

This mode of attack upon the nucleus at once proved successful. I found in 1919 that nitrogen could be transformed by bombardment with fast α-particles. The process of transmutation is now clear. Occasionally an α-particle actually enters the nitrogen nucleus and forms with it a new unstable nucleus which instantly breaks up with the emission of a fast proton (hydrogen nucleus) and the formation of a stable isotope of oxygen of mass 17. About a dozen of the light elements were found to be transformed in a similar way. The protons liberated in the nuclear explosions were at first counted by observing the flashes of light (scintillations) produced in phosphorescent zinc sulphide. This method was slow and very trying to the eyes of the observers. Progress, however, became more rapid and definite when electrical methods of counting individual fast particles were developed. These electrical counters, mainly depending on the use of electron tubes for magnifying small currents, have now reached such a stage of perfection that we are able to count automatically individual fast particles like α-particles and protons even though they enter the

detecting chamber at a rate as fast as ten thousand per minute. By other special devices, we are in like manner able to count individual β-particles. In this connexion, I must not omit to mention that wonderful instrument, the Wilson expansion chamber, which makes visible to us the actual tracks of flying fragments of atoms resulting from an atomic explosion. These remarkable devices have played an indispensable part in the rapid growth of knowledge during the last few years. It is to be emphasized that progress in scientific discovery is greatly influenced by the development of new technical methods and of new devices for measurement. With the growing complexity of science, the development of special techniques is of ever-increasing importance for the advance of knowledge.

Up to the year 1932, experiments on transmutation were confined to the use of α-particles for bombarding purposes. It became clear that the process of transformation was in most cases complex, since groups of protons with different but characteristic energies were observed when a single element was bombarded. This led to the conception that discrete energy levels existed within a nucleus, and that under some conditions part of the excess energy was sometimes released in the form of a quantum of high-frequency radiation.

The stage was now set for a great advance, and four new discoveries of outstanding importance were made in rapid succession in the period 1931–33. I refer to the discovery of the positive electron by Anderson in 1931, of the neutron by Chadwick in 1932, of artificial radioactivity by M. and Mme. Curie-Joliot in 1933 and of the transmutation of the elements by purely artificial methods first shown by Cockcroft and Walton in 1932.

The discovery of the neutron—that uncharged particle of mass nearly 1—was the result of a close study of the effects produced in the light element beryllium when bombarded by α-particles. It is noteworthy that the proton and neutron, which are now believed to be the essential units with which all atomic nuclei are built up, owe their recognition to a study of the transmutation of matter by α-particles.

Before the discovery of the neutron, it had been perforce assumed that nuclei must in some way be built up of massive protons and light negative electrons. Theories of nuclear structure became much more amenable to calculation when the nucleus was considered to be an aggregate of parts like the proton and neutron which have nearly the same mass. There was no longer any need to assume that either the positive or the negative electron has an independent existence in the nuclear structure. We are still uncertain of the exact relation, if any, between the neutron and the proton. The neutron appears to be slightly more massive than the proton, but it is generally believed, although no definite proof is available, that the proton and neutron within a nucleus are mutually convertible under certain conditions. For example, the change of a proton into a neutron within the nucleus should lead to the appearance of a free positive electron, while conversely the change of a neutron into a proton gives rise to a free negative electron. In this way it appears possible to account for the observed fact that either positive or negative electrons are emitted by a large group of radioactive elements to which I will now refer.

In the early experiments on transmutation by α-particles, it was supposed that a stable nucleus was always formed after the emission of a fast proton. The investigations of M. and Mme. Curie-Joliot showed that in some cases elements were formed which, while momentarily stable, ultimately broke up slowly, exactly like the natural radioactive bodies. Most of these radioactive bodies formed by artificial methods break up with the expulsion of fast negative electrons, but in a few cases positive electrons are emitted. Since the presence of these radioactive bodies can be easily detected, and their chemical properties readily determined, this new method of attack on the problem of transmutation has proved of great value. Nearly a hundred of these radioactive bodies are now known, produced in a great variety of ways. Some arise from the bombardment by fast α-particles, others by bombardment with protons or deuterons. As Fermi and his colleagues have shown, neutrons, and particularly slow neutrons, are extraordinarily effective in the formation of such radioactive bodies. On account of its absence of charge, the neutron enters freely into the nuclear structure of even the heaviest element, and in many cases causes its transmutation. For example, a number of these radioactive bodies are produced when the two heaviest elements, uranium and thorium, are bombarded by slow neutrons. In the case of uranium, as Hahn and Meitner have shown, the radioactive bodies so formed break up in a succession of stages like the natural radioactive bodies, and give rise to a number of trans-uranic elements of higher atomic number than uranium (92). These radioactive elements have the chemical properties to be expected from the higher homologues of rhenium, osmium and iridium of atomic numbers 93, 94 and 95.

These artificial radioactive bodies in general represent unstable varieties of the isotopes of known elements which have a limited life. No doubt such transient radioactive elements are still produced by transmutation in the furnace of our

sun, where the thermal motions of the atoms must be very great. These radioactive elements would rapidly disappear as soon as the earth cooled down after separation from the sun. On this view, uranium and thorium are to be regarded as practically the sole survivors in our earth of a large group of radioactive elements, owing to the fact that their time of transformation is long compared with the age of our planet.

It is of interest to note what an important part the α-particle, which is itself a product of transformation of the natural radioactive bodies, has played in the growth of our knowledge of artificial transmutation. It is to be remembered, too, that our main source of neutrons for experimental purposes is provided by the bombardment of beryllium with α-particles. The amount of radium available in our laboratories is, however, limited, and it was early recognized that if our knowledge of transmutation was to be extended, it was necessary to have a copious supply of fast particles of all kinds for bombarding purposes. It is well known that enormous numbers of protons and deuterons, for example, can be easily produced by the passage of the electric discharge through hydrogen and deuterium (heavy hydrogen). To be effective for transmutation purposes, however, these charged particles must be given a high speed by accelerating them in a strong electric field. This has involved the use of apparatus on an engineering scale to provide voltages as high as one million volts or more, and the use of fast pumps to maintain a good vacuum.

A large amount of difficult technical work has been necessary to produce such high D.C. voltages and to find the best methods of applying them to the accelerating system. In Cambridge, these high voltages are produced by multiplying the voltage of a transformer by a system of condensers and rectifiers; in the United States of America by the use of a novel type of electrostatic generator, first developed by van der Graaf. Prof. Lawrence, of the University of California, has devised an ingenious instrument called a 'cyclotron' in which the charged particles are automatically accelerated in multiple stages. This involves the use of huge electromagnets and very powerful electric oscillators. By this method he has succeeded in producing streams of fast particles which have energies as high as the α-particle ejected from radioactive substances. Undoubtedly this type of apparatus will prove of great importance in giving us a supply of much faster particles than we can hope to produce by the more direct methods.

It was at first thought that very high potentials of the order of several million volts would be required to obtain particles to study the transmutation of elements. Here, however, the development of the theory of wave-mechanics came to the aid of the experimenter, for Gamow showed that there was a small chance that comparatively slow bombarding particles might enter a nucleus. This theoretical conclusion has been completely verified by experiment. In the case of a light element like lithium, transformation effects can be readily observed with protons of energy as low as 20,000 volts. Of course, the amount of transformation increases rapidly with rise of voltage.

The study of the transmutation of elements by using accelerated protons and deuterons as bombarding particles has given us a wealth of new information. The capture of the proton or deuteron by a nucleus leads in many cases to types of transmutation of unusual interest. For example, the bombardment of the isotope of lithium of mass 7 by protons leads to the formation of a beryllium nucleus of mass 8 with a great excess of energy. This immediately breaks up into two α-particles shot out in nearly opposite directions. When boron 11 is bombarded by protons, a carbon nucleus of mass 12 is formed which breaks up in most cases into three α-particles. The deuteron is in some respects even more effective than the proton as a transmuting agent. When deuterons are used to bombard a compound of deuterium, previously unknown isotopes of hydrogen and of helium of mass 3 are formed, while fast protons and neutrons are liberated. The bombardment of beryllium by very fast deuterons gives rise to a plentiful supply of neutrons. Lawrence has shown that the bombardment of bismuth by very fast deuterons leads to the production of a radioactive bismuth isotope which is identical with the well-known natural radioactive product radium E. Many artificial radioactive elements can be produced, often in great intensity. For example, the bombardment of common salt by fast deuterons gives rise to a radioactive isotope of sodium. This breaks up with a half period of 15 hours, emitting not only fast β-particles but also γ-rays at least as penetrating as those from radium.

It may well be that in course of time such artificial radioactive elements may prove a useful substitute for radium in therapeutic work. By these methods also, such intense sources of neutrons can be produced that special precautions have to be taken for the safety of the operators of the apparatus.

Sufficient I think has been said to illustrate the variety and interest of the transmutations produced by these bombardment methods. It should, however, be pointed out that transmutation in some cases can be effected by transferring energy to a nucleus by means of γ-rays of high quantum energy instead of by a material particle. For example, the deuteron can be broken up into its

components, the proton and neutron, by the action of the γ-rays from radium or thorium. As a result of the bombardment of lithium by protons, γ-rays of extraordinarily great quantum energy as high as 17 million volts are strongly emitted. Bothe has recently shown that these high-energy rays are able to transmute a number of atoms, neutrons usually being emitted in the process.

Some simple laws appear to hold in all individual transformations so far examined. Nuclear charge is always conserved, and where heavy particles are emitted, so also is energy when account is taken of the equivalence of mass and energy. Certain difficulties arise with regard to the conservation of energy in cases where light positive and negative electrons are emitted during transmutation, and there is still much discussion on this important question.

The study of the transmutation of matter has been extraordinarily fruitful in results of fundamental importance. In addition to the α-particle, it has disclosed to us the existence of those two building units of nuclei, the proton and neutron. It has greatly widened our conception of the varieties of atomic nuclei which can exist in Nature. Not only has it led to the discovery of about one hundred new radioactive elements, but also of several stable isotopes of known elements, like ^{2}H, ^{3}He, ^{8}Be, which had previously been unsuspected. It has greatly extended our knowledge of the ways in which nuclei can be built up and broken down, and has brought to our attention the extraordinary violence of some of the nuclear explosions which occur. The great majority of our elements have been transmuted by the bombardment method, and in the case of the light elements which have been most carefully studied, a great variety of modes of transmutation has been established.

Rapid progress has been made, but much still remains to be done before we can hope to understand the detailed structure and stability of different forms of atomic nuclei and the origin of the elements. I cannot but reflect on the amazing contrast between my first experiment on the transmutation of nitrogen in the University of Manchester in 1919 and the large-scale experiments on transmutation which are now in progress in many parts of the world. In the one case, imagine an observer in a dark room with very simple apparatus painfully counting with a microscope a few faint scintillations originating from the bombardment of nitrogen by a source of α-particles. Contrast this with the large-scale apparatus now in use for experiments on transmutation in Cambridge. A great hall contains massive and elaborate machinery, rising tier on tier, to give a steady potential of about two million volts. Nearby is the tall accelerating column with a power station on top, protected by great corona shields—reminding one of a photograph in the film of Wells's "The Shape of Things to Come". The intense stream of accelerated particles falls on the target in the room below, with thick walls to protect the workers from stray radiation. Here is a band of investigators using complicated electrical devices for counting automatically the multitude of fast particles arising from the transformation of the target element, or photographing with an expansion chamber, automatically controlled, the actual tracks of particles from exploding atoms.

To examine the effect of still faster particles, a cyclotron is installed in another large room. The large electromagnet and accessories are surrounded with great water tanks containing boron in solution to protect the workers from the effect of neutrons released in the apparatus. A power station nearby is needed to provide current to excite the electromagnet and the powerful electric oscillators.

Such a comparison illustrates the remarkable changes in the scale of research that have taken place in certain branches of pure science within the last twenty years. Such a development is inevitable, for, as science progresses, important problems arise which can only be solved by the use of large powers and complicated apparatus, requiring the attention of a team of research workers. If rapid progress is to be made, such team work is likely to be a feature of the more elaborate researches in the future. Fortunately there is still plenty of scope for the individual research worker in many experiments of a simpler kind.

The science of physics now covers such a vast field that it is impossible for any laboratory to provide up-to-date facilities for research in more than a few of its branches. There is a growing tendency in our research laboratories to-day to specialize in those particular branches of physics in which they are most interested or specially equipped. Such a division of the field of research amongst a number of universities has certain advantages, provided that this subdivision is not carried too far. In general, the universities should be left free so far as possible to develop their own lines of research and encouraged to train young investigators, for it cannot be doubted that vigorous schools of research in pure science are vital to any nation if it wishes to develop effectively the application of science, whether to agriculture, industry or medicine. Since investigations in modern science are sometimes costly, and often require the use of expensive apparatus and large-scale collaboration, it is obviously essential that adequate funds should be available to the universities to cover the cost of such researches.

Progress in Chemotherapy

PEOPLE in settled and civilized countries, such as Great Britain, are familiar with the beneficent results of the application of the methods of preventive medicine, but these methods are not easy to apply among primitive populations, and in the tropical parts of the Empire the effects of preventive methods are apt to be much less apparent than those brought about by curative medicine, making use of the products of chemotherapeutical investigation, in the treatment of endemic plagues such as malaria, sleeping sickness, bilharzia, hookworm disease and kala-azar. It is fitting that the value of such work should be recognized, and the decision of His Majesty's Government to spend £30,000 per annum in promoting chemotherapeutical investigations is a welcome move in the right direction. Although work of this kind has not so far been undertaken in Great Britain on so large a scale as in some Continental countries, the amount done is by no means negligible, as was evident from the partial survey of recent work made in the course of a discussion on "The Influence of Structure on the Action of Parasiticidal Drugs" held under the auspices of the Chemical Society on Thursday December 2, in which both biologists and chemists took part.

In his opening remarks, Dr. T. A. Henry suggested that such investigations are usually conducted in one of two ways. The method by which most of the practical successes of chemotherapy have been achieved depends upon the discovery of a clue in the form of a drug to which the pathogenic organism associated with a disease is more or less vulnerable. The course of such an investigation was illustrated by a brief account of work on kala-azar, which, starting with the observation in 1915 that this disease could be successfully treated by tartar emetic, resulted in the replacement of that unpleasant drug by derivatives of *p*-aminophenylstibonic acid, made possible by Dr. Hans Schmidt's discovery in 1911 of a method of preparing arylstibonic acids[1]. The second method depends upon the idea that toxicity to a range of parasites may be associated with a particular type of chemical structure, and that pharmacological investigation of a series of drugs in which the structural type is maintained may afford useful information as to the mode of action of such drugs—a difficult subject upon which there has been much speculation, but little real progress. At present such investigations are in progress on the influence of chemical modification on the action of cinchona alkaloids in bird malaria and auricular fibrillation[2] and on their pneumococcicidal activity[3]. It has been found that modification of the vinyl side-chain in quinine and quinidine makes little difference to anti-malarial action, but that any interference with the central –CHOH– group reduces or extinguishes activity, even when there is only a change in spatial distribution, as in the conversion of quinine into Rabe's *epi*-C^9-quinine. In a homologous series of *apo*quinine or dihydrocupreine alkyl ethers, anti-malarial action does not rise to a maximum and then fall as the series is ascended, but shows this behaviour in an alternating form, the members with odd and even numbers of carbon atoms forming two sub-series, each giving an independent maximum.

Discussing the biological side of such investigations, Dr. J. W. Trevan said that even when allowance is made for the crudity of the pharmacological methods available and the variability of the test object, there is no doubt that small structural changes do profoundly modify the pharmacological action of many substances, which is not surprising in view of the narrow limits of tolerance for environmental change shown by living cells. Mere methylation of an amino-group may reduce the anæsthetic action of a compound by reducing the concentration of base free at the hydrogen ion concentration of the body. The difference in effect between the chains of odd and even numbers of carbon atoms referred to by Dr. Henry may be due to differences in spatial arrangement. Müller has shown that the normal paraffins have the carbon atoms arranged in a zig-zag form. It is not unlikely that these drugs act on a surface film of the cell composed of protein, possibly containing some such substance as cholesterol, possessing a recurrent pattern. If the drug is anchored by the characteristic group of the alkaloid and the plane of the zig-zag is at right angles to the surface with its axis parallel with the surface, the distance of the terminal methyl group will not be the same for the odd and even numbered chain, and it would be interesting to construct a model of the molecule and to determine whether such an explanation is feasible.

Prof. F. L. Pyman summarized briefly the results of his work on *n*-alkylphenols and on amœbicides, of which an account has been published recently in NATURE (**140**, 409, 832; 1937). The results are of special interest as showing that amœbicidal action *in vitro* is exhibited by compounds wholly different in structure from emetine,

the most active substance found being α ×-tetra-*n*-amyldiamino-*n*-decane, which, however, proved not to be of clinical value.

Sir Gilbert Morgan then gave an account of work done on homologous series of derivatives of *p*-aminophenylarsonic acids of the general formula $(HO)_2AsO.C_6H_4.NH.CO(CH_2)_n.CO.NR_1R_2$, which may be regarded as combining the desirable features of the well-known arsenical drugs, acetyl-*p*-arsanilic acid and tryparsone, (NaO)(OH).$AsO.C_6H_4.NH.CH_2.CONH_2$, the latter being probably the most widely used drug of this type for the treatment of sleeping sickness and late syphilis. Among the new drugs, sodium succinanilomethylamide-*p*-arsonate ($n = 2$; $R_1 = H$; $R_2 = CH_3$) has been selected and has already given promising results in clinical trials in sleeping sickness in Nigeria. In connexion with the same investigation, Dr. E. Walton directed attention to the low toxicity of this type of arsenical compound, and showed that trypanocidal action is enhanced by an amide-group in the *p*-position in phenylarsonic acid[4].

The next two contributions dealt with the new streptococcicidal drugs, of which the first example was Domagk's 2 : 4-diaminoazobenzene-4′-sulphonamide[5], which was speedily shown, as the result of work in France and in Great Britain, to be replaceable by the simpler substance *p*-aminobenzenesulphonamide (sulphanilamide), which is already in use on a large scale. Mr. W. H. Gray stated that the results of numerous attempts to improve upon this simple substance indicated that both the sulphur atom and the amino-group are essential, that duplication of either on the same nucleus destroys activity, which is also the effect of additional substituents. A more active but more toxic substance is 4 : 4′-diaminodiphenylsulphone, in which activity also disappears on elimination of either the sulphone or the amino-groups. Dealing with biological work on these drugs, Dr. G. A. H. Buttle said that sulphanilamide will cure mice infected with 10,000 times the lethal dose of streptococci. As tested on mice, the drug appears to have some action in all bacterial infections characterized by rapid multiplication of the invading bacterium, but it fails in infections where a small number of organisms can produce a sufficiently potent toxin to kill the animal, as in diphtheria. As regards the mode of action, there is experimental evidence for the view that by some means still unknown the drug delays the growth of the organisms or affects them in such a manner as to facilitate their destruction by the leucocytes of the blood[6].

Returning to anti-malarial drugs, Dr. H. King described work done in collaboration with Dr. Cohen and Dr. Ainley on two substances based on the structure of quinine, details of which will be published shortly.

Dr. W. H. Linnell showed that although there are a number of useful acridine derivatives in use in medicine as bactericides and amœbicides, the possibilities of this heterocyclic nucleus have not been fully explored, and in his recent survey[7] of monoamino- and diamino-acridines, he has found that 1-aminoacridines are not bactericidal, that an amino-group in position 3 lowers toxicity and that 3 : 8-diaminoacridine is as active as, but much less toxic than, the well-known 2 : 8-diaminoacridine (proflavine).

[1] Schmidt, *Z. angew. Chem.*, **43**, 963 (1930). Gray and Trevan, *Trans. Roy. Soc. Trop. Med. Hyg.*, **25**, 147 (1931).
[2] See, for example, van Dongen and Sanches, *Arch. intern. Pharmacodyn.*, **55**, 52 (1937).
[3] Butler, Hostler and Cretcher, *J. Amer. Chem. Soc.*, **59**, 2354 (1937).
[4] Morgan and Walton, *Chem. and Ind.*, **56**, 853 (1937).
[5] Domagk, *Deut. med. Woch.*, **61**, 250 (1935).
[6] Gray, Buttle and Stephenson, *Biochem. J.*, **31**, 724 (1937).
[7] Albert and Linnell, *J. Chem. Soc.*, 88, 1614 (1936); also a further paper in the Press.

The Quatercentenary of the University of Coimbra

THE beautiful old city of Coimbra, the ancient capital of the kingdom of Portugal from the time of King Afonso Henriques to that of King Afonso III, rises picturesquely from the banks of the Mondego River and is crowned by the historic buildings of its university. The first centre of higher learning in Portugal, the first "Estudo geral", was established at Lisbon in March 1290 by King Diniz, but was later brought to the capital at Coimbra (in 1308). Twice transferred back in the fourteenth century (1338 and 1377) to the banks of the Tagus, the University was finally established at Coimbra in 1537 by King John III, who had undertaken a great reform of university studies. These reforms culminated in the reign of King José I, when in the last quarter of the eighteenth century his famous Prime Minister, the Marqués de Pombal, greatly transformed and modernized the work of the University, introducing especially the study of natural science.

The four hundredth anniversary of the final establishment of the University at Coimbra in 1537 was celebrated during the days December 6–10 by a series of fine ceremonies and much

splendid hospitality. Many men of letters and science had come from various parts of the world to do honour to the famous University, and were entertained in a most lavish manner by the Government of Portugal, the University authorities, and the City of Coimbra.

The British guests who had come specially to Portugal for the quatercentenary were Prof. F. G. Donnan (chemistry, University of London and the Royal Society) and Miss Jane Donnan, Prof. W. J. Entwistle (Spanish and Portuguese, University of Oxford), Mr. J. Ramsbottom (keeper of botany, British Museum (Natural History)), Prof. W. F. Starkie (Spanish and Italian, Trinity College, Dublin) and Prof. W. M. Thornton (electrical engineering, Universities of Durham, Birmingham, Reading and Bristol). The British Embassy in Lisbon was represented by the chargé d'affaires, Mr. Bateman, and the secretary, Mr. Gorell-Barnes (who also represented the University of Cambridge), whilst Mr. Dible, British Consul in Oporto, represented the consular service. Notable amongst those who represented the British colony in Lisbon were Mr. R. G. Jayne, head of the well-known shipping firm of Garland, Laidley and Co., and the Rev. Stewart Robertson (who also represented the University of Edinburgh) and Mrs. Robertson.

The celebrations began in the afternoon of December 6 with a general assembly in the "Patio" of the University, followed by addresses of welcome and a reception in the splendid official apartments of the distinguished Rector of the University, Dr. João Duarte de Oliveira.

During the forenoon of December 7 an exhibition of books was opened in the general Library of the University. This building, constructed between 1717 and 1725 on the initiative of the Rector, Nuno da Silva Teles, is a magnificent example of the Portuguese baroque style of the period of King John V, and contains a vast store of valuable manuscripts and books. There was also opened at the same time a most interesting display of early documents in the archives of the University.

At noon came addresses of welcome by the City Council and a reception in the University; the President of the Republic, his Excellency General Oscar de Fragoso Carmona, had intended to be present, but he was prevented from doing so by indisposition.

Most of the afternoon of December 7 was dedicated to a solemn session in the famous "Sala dos Capêlos" of the University. This noble hall was the work of the Rector, Manuel de Saldanha, who in 1654 decided to transform and embellish the great salon of the Royal Palace which at that time served for the ceremonies of the University. It possesses a fine dado of the beautiful "azulejos", that is, painted and glazed tiles, for which Portugal is so famous, and a splendid domed ceiling of painted panels, whilst its walls are adorned by portraits of the kings and queens of Portugal. Addresses were delivered by the Rector and the Minister of Education, Dr. Antonio Faria Carneiro Pacheco, and Prof. Damião Peres gave an eloquent account of the University of Coimbra in the history of Portuguese culture. Then short speeches of congratulation were made by members of the various foreign delegations, Prof. Entwistle speaking in Portuguese on behalf of the representatives of Great Britain.

The afternoon of December 7 concluded with the inauguration of the "Sala do Brasil" in the Faculty of Letters. In the evening a splendid gala dinner was given in the University, at which were present the diplomatic corps and the senior delegates of the various nations. This was followed by a concert given by the symphony orchestra of the national broadcasting station. The Prime Minister, his Excellency Dr. Antonio de Oliveira Salazar, was able to be present during a part of these festivities.

At 11 o'clock on the morning of December 8, High Mass was celebrated by his Eminence the Cardinal Patriarch of Portugal, whilst during the afternoon in the Sala dos Capêlos, Senhor Mario Brandão was admitted to the degree of doctor, and honorary doctorates were conferred on a number of the foreign delegates, including Prof. Donnan and Mr. Ramsbottom. This was a scene never to be forgotten by the visitors. Round the great hall sat the diplomatic corps and the professors of the various faculties, the latter clad in their black gowns and silken "capelos" (differing in colour for each faculty) and wearing on their heads the wonderful "borlas" or academic hats. The body of the hall was filled with many ladies and guests of the University, whilst at the back surged an enthusiastic throng of students who gave Dr. Brandão and the honorary doctors a very hearty welcome. An extremely interesting feature of this ancient and historic ceremony was the embracing of the Rector Magnificus and the dean of the faculty by each honorary doctor in turn, whilst Dr. Brandão had the further privilege of being led round the stalls and the duty of embracing all the members of the faculties. One realized that this was a noble ceremony characteristic of the ancient brotherhood of learning, in which every new doctor was admitted to a special order and given a very friendly welcome by his elder brothers.

In the evening of December 8 a great banquet was given by the City Council in the hall of the splendid new High School named after King John III. At this banquet many students, all

clad in their characteristic long black gowns, were present, so the proceedings were much enlivened by the gaiety and joy of youth. Various foreign delegates (including the present writer) were haled from the high table by groups of very pleasant fellows, given a student's gown, and conducted round the hall amidst cheers and rejoicing. One signed innumerable cards, drank much of the good wine of the country to the honour of Coimbra and Portugal, tried to speak bad Portuguese, and endeavoured to keep one's head and feet. It was evident that these good fellows, the representatives that night of the hope of the world, were admitting us to their comradeship and to the fellowship of the University of Coimbra. May God bless them!

On December 9 the programme included a football match and a torchlight procession of the students. Unfortunately, these events had to be cancelled owing to heavy rain. However, there was a very interesting concert of Portuguese music in the afternoon, given by the Philharmonic Orchestra of Lisbon, an evening meeting in the Avenida Theatre, and a gala ball in the great High School of King John III.

The celebrations closed on December 10 with a visit to the beautiful mountain resort of Buçaco and a lunch in the Palace Hotel. Thus terminated a visit to Coimbra and its famous University which will live in the memories of the British delegates as one of the pleasantest and most interesting events of their lives. The old city of Coimbra, crowned by its ancient University, and with its great Romanesque Cathedral of Sé Velha and its old church of Santa Cruz, in which lie buried King Afonso Henriques and King Sancho I, will ever remain with us a vivid and happy memory. We retain also a keen appreciation of the present as well as of the glorious past, and rejoice to have seen with our own eyes the great advances made in the University of Coimbra, as elsewhere in the land of our ancient and loyal allies, under the wise and beneficent leadership of President General Carmona and his great Prime Minister, Dr. Salazar. Dr. Salazar himself is a man of learning, one of the greatest, if not the greatest, of the sons of his Alma Mater, Coimbra. A distinguished professor of that University, destiny has led him to dedicate his pre-eminent abilities and virtues to the prosperity and happiness of the land of his birth. We who have experienced the splendid hospitality of his Government, and have had the privilege of witnessing the great and beneficent results of his wise and patriotic leadership of the Portuguese nation, unite wholeheartedly in wishing him and all our good friends of Portugal every prosperity and happiness in the future.

Before leaving Coimbra, I spent a very pleasant afternoon in the company of the professors of chemistry, Prof. Ruy Gustavo Couceiro da Costa and Prof. K. Coper. A remarkable experience was the visit to the Chemical Laboratory, a building in the neo-classical style erected in the last quarter of the eighteenth century during the reform period of the Marqués de Pombal (who approved and signed the architect's plan). How it would have rejoiced the heart of Lavoisier! Certainly the great Marquis must have been a man of remarkable foresight, and one cannot blame him or his architect for not having designed a building suitable to the requirements of 1937. Various interesting researches were in progress—a proof that good work can be done in buildings of great historical interest. Nevertheless, in case these lines should meet the eyes of Dr. Salazar—which is, perhaps, unlikely—I would humbly suggest that now is the time for him to beat the record of the great Marquis!

Another very interesting visit was paid to the English Institute, due to the energy and initiative of Dr. West, and now under the able direction of Mr. Leonard S. Downes, who represented the University of Glasgow at the celebrations. Amongst many other things, one was astonished to find here a library containing some English scientific journals and a goodly number of the most modern English books on chemistry and physics. In fact, the professors of chemistry told me that they were much indebted to the English Institute for keeping them in touch with the progress of British science. It is evident that the English Institute is very much alive and worthy of the strongest support. In the modern world the 'invisible' export of thought is an element of deep significance and importance. Britons in the past have been too apt to think that foreign nations are bound to assimilate the products of their thought and research by reason of some sort of inevitable predestination. This curious diffidence—or sublime trust in Providence—is not much good in the rough catch-as-catch-can of the thrusting modern world.

So, at last, came the train that bore us away from this city of learning, poetry and romance, where immortal Camões once lived and beautiful Inéz de Castro loved and suffered. With every student of Coimbra one could exclaim, "Não é Universidade como a minha!"

In conclusion, the British visitors to the Coimbra quatercentenary are deeply indebted to His Majesty's Embassy at Lisbon for invaluable help and much personal care and attention. Several of us, including the writer of this article, desire also to express our grateful thanks to Mr. Pell, the Minister of the United States in Portugal, and Mrs. Pell, for very delightful hospitality.

F. G. DONNAN.

Obituary Notices

Prof. Charles Gravier

PROF. CHARLES GRAVIER, of the Natural History Museum of Paris, died on November 15 in his seventy-third year. Born at Orléans in 1865, and educated at the Ecole Normale of Saint-Cloud, he made his first step in the academic service of his country with an appointment in 1887 to a professorship at the Ecole Normale of Grenoble. In 1893, he was *agrégé des Sciences Naturelles* and in 1894 became *Professeur de Lycée* at Clermont-Ferrand, and two years later obtained his doctorate with a thesis on the Polychæta entitled "Recherches sur les Phyllodociens".

From Clermont-Ferrand Gravier moved to Paris, where he held the post of assistant first to E. Perrier and afterwards to L. Joubin at the Natural History Museum. In 1917 he was appointed *Professeur au Muséum* (*Vers et Crustacés*), a chair which he held until his death, and in 1922 he was elected a member of the Paris Academy of Sciences. He married a lady who also belonged to the academic world, for she held a chair of mathematics at the Ecole Normale of Sèvres, and their only son Maurice is a student of Scandinavian and Germanic philology.

Gravier saw more of the world than most men that follow an academic career, for he worked at the Zoological Station at Naples, at Bergen, in Germany, and was familiar with all the principal European museums. He went twice to America, and was entrusted with two scientific missions, to San Thomé in the Gulf of Guinea and afterwards to Djibouti in the Red Sea.

Gravier's life was devoted to the study of marine zoology, and his great powers of work enabled him to cover a wide field. He was mainly preoccupied with the systematics and morphology of the Polychæta and the Cœlenterates, but he was also deeply interested in their bionomics, and he had the capacity of extracting the last ounce of evolutionary significance from his material. He wrote upwards of eighty papers on the Cœlenterates, dealing with nearly all the groups of that phylum, and about a hundred and thirty papers on the Polychæta, of which nearly thirty were in collaboration with J. L. Dantan. He also published on the Crustacea and sponges.

Much of Gravier's work was in the form of short notes, two or three pages in length, but he also contributed a number of substantial memoirs. For example, in the Cœlenterates he described the corals of the second French Antarctic expedition and also those collected by the Prince of Monaco's oceanographic expeditions. In the Crustacea he described in 1912 the parasitic Copepoda of the second French Antarctic expedition and in 1931 published a valuable account of the breeding habits of the group. The bulk of his work was on the Polychæta, and in this group his main contributions were the description of the Polychæta of the first and second French Antarctic expeditions, his memoir on the Polychæta of the Red Sea, his papers on the breeding habits of the group, and more recently his account in collaboration with J. L. Dantan of the planktonic Polychætes obtained by fishing at night with a light in the Bay of Algiers and off the coast of Annam. He also made a special study of freshwater Polychætes.

All Gravier's work was careful and finished, and displayed the characteristic French clarity, proportion and sense of style. As a man, he had great charm. He never obtruded his great learning and always remained courteous, unassuming and kind.

C. C. A. M.

Prof. E. L. Nichols

ON November 10 the death occurred of Prof. E. L. Nichols, emeritus professor of physics in Cornell University, in his eighty-fourth year. Prof. Nichols's connexion with Cornell was of very long standing, as he studied there from 1871 until 1875 and was appointed professor of physics in the University in 1887. Thus for the past fifty years he has been continuously associated with Cornell, his appointment as emeritus professor dating from 1919. Previous to 1887, he had held the post of professor of physics, first at the University of Kentucky and then at Kansas University.

The period through which Prof. Nichols lived was one of most active and intense development in the realm of physics; this will be the more readily appreciated from the fact that he was for a short time associated with Edison in the development of the incandescent lamp. Throughout his life, his most constant interest was in photometry, optics and fluorescence, and he was responsible for a very large number of papers on various aspects of these subjects. His investigations of fluorescent phenomena were particularly numerous, and the book he wrote in collaboration with H. L. Howes and D. T. Wilbur on "Cathodo-Luminescence and the Luminescence of Incandescent Solids" is probably his most important work. Measurements of fluorescence are difficult at any time, and in his early work Prof. Nichols must have been very seriously hampered by the absence of the photometric standards to which we are now accustomed; but it must have been a source of considerable interest and satisfaction to him to see the rapidly growing industrial importance of the subject of fluorescence during the last few years, in connexion with new forms of lighting devices and with cathode ray tube development.

In addition to his own research activities, Prof. Nichols played an important part at the end of the last century in placing research in its correct perspective in American universities. At that time, teaching was almost the sole concern of the staffs of the various universities, and it is largely due to

the energy and foresight of men such as him that at the present time the majority of American universities recognize research as being one of their most important functions.

In 1929, Prof. Nichols was awarded the Ives Medal of the Optical Society of America, and the present writer recollects with pleasure the dinner at which the medal was presented, and the speech by the late Mr. I. G. Priest, then president of the Society, in which he referred in glowing terms to the great service the medallist had rendered to optics.

W. D. W.

THE death is reported from Wellington, New Zealand, of Dr. Herbert William Williams, Bishop of Waiapu and well known as a Maori scholar, which took place on December 7 at the age of seventy-seven years. Dr. Williams was the third in descent of his family to hold this bishopric, both his grandfather and his father having held it before him. Dr. Williams was born at Waeranga-a-hika and was educated at Christ's College, Christchurch, and Canterbury College. After graduating in the University of New Zealand, he held a scholarship at Jesus College, Cambridge, where he graduated as a senior optime in 1884. After a brief period as a master at Haileybury he was ordained. In 1888 he returned to New Zealand, and in 1929 was elected to succeed Bishop Sedgwich in this diocese. Dr. Williams's life-long acquaintance and friendship with the Maori gave him an exceptional position as an authority on their history and culture. He was the author of a Maori dictionary, which appeared in 1917, of a bibliography of printed Maori, which appeared in 1924, and of "First Lessons in Maori". His scholarship was recognized by the award of the degree of Litt.D. of the University of New Zealand in 1924 and of the Litt.D. of Cambridge in 1925. He was a fellow of the Royal Society of New Zealand, of which he was president in 1935. He was also president of the Polynesian Society in 1929.

WE regret to announce the following deaths :

Prof. G. A. Buckmaster, emeritus professor of physiology in the University of Bristol, on December 19, aged seventy-eight years.

Mr. A. G. Edie, C.I.E., formerly chief conservator of forests, Bombay, on December 18, aged sixty-five years.

Prof. L. N. G. Filon, C.B.E., F.R.S., Goldsmid professor of mathematics in the University of London, formerly vice-chancellor of the University, on December 29, aged sixty-two years.

Miss Elizabeth Sanderson Haldane, C.H., author of works on Descartes, Ferrier and Hegel, and known for her interest in adult education, on December 24, aged seventy-five years.

Rear-Admiral R. S. Patton, since 1929 director of the U.S. Coast and Geodetic Survey, on November 25, aged fifty-four years.

Dr. Ivan K. Urumoff, known for his work on the flora of Bulgaria, aged eighty-one years.

News and Views

New Year Honours

THE New Year Honours list contains the names of the following men of science and others associated with scientific work: *Viscount*: Lord Nuffield, for public and philanthropic services. *Baron*: Sir Henry Lopes, Bt., deputy president of the University College of the South West, Exeter. *G.C.V.O.*: Lord Horder. *G.B.E.*: Sir Andrew Duncan, chairman of the Central Electricity Board, 1927–35. *K.C.B.*: Mr. K. McK. Clark, director of the National Gallery and surveyor of the King's Pictures. *K.B.E.*: Mr. T. Rigg, director of the Cawthron Institute, Nelson, Dominion of New Zealand; Dr. W. H. McLean, for services to education and economic development in the Colonies; Dr. W. D. Ross, president of the British Academy and provost of Oriel College, Oxford. *Knights*: Dr. Zia-Uddin Ahmad, vice-chancellor of the Aligarh Muslim University, United Provinces, India; Prof. G. A. R. Callender, first director of the National Maritime Museum; Mr. W. Palin Elderton, chairman of the British Insurance Association, actuary and manager of the Equitable Life Assurance Society; Mr. W. Reavell, lately president of the British Engineers' Association; Dr. W. G. Savage, county medical officer of health, Somerset; Dr. T. F. Sibly, vice-chancellor of the University of Reading, member of the Advisory Council of the Department of Scientific and Industrial Research; Mr. J. P. Ross-Taylor, chairman of the Highland and Agricultural Society; Dr. C. McM. Wilson, dean of St. Mary's Hospital Medical School; Mr. D. R. Wilson, H.M. Chief Inspector of Factories, Home Office.

C.B.: Major-General W. P. MacArthur, honorary physician to the King, commandant and director of studies, Royal Army Medical College, Millbank; Major-General A. E. Davidson, director of mechanization, War Office. *C.M.G.*: Mr. F. Hemming, secretary to the International Committee for the Application of the Agreement regarding Non-intervention in Spain, who is secretary of the International Commission of Zoological Nomenclature; Dr. P. H. Manson-Bahr, consulting physician to the Colonial Office; Dr. J. D. Tothill, director of agriculture, Uganda Protectorate. *C.I.E.*: Mr. C. F. Bell, chief conservator of forests, Central Provinces and Berar; Lieutenant-Colonel G. T. Burke, lately

secretary, Medical Council of India; Dr. C. W. B. Normand, director-general of observatories, Government of India; Khan Bahadur Shapurji Nasarvanji Jamshedji Ratnagar, lately conservator of forests, Southern Circle, Bombay. *C.B.E.:* Mr. J. B. Beresford, secretary of the University Grants Committee and also of the Standing Commission on Museums and Galleries; Mr. J. Dewar, surveyor-general, Federated Malay States and Straits Settlements; Mr. H. J. G. Griffin, secretary of the Council for the Preservation of Rural England; Mr. A. L. Hetherington, assistant secretary of the Department of Scientific and Industrial Research; Dr. J. W. Mellor, lately director of the British Refractories Research Association; Dr. E. C. Snow, joint honorary secretary of the Royal Statistical Society; Dr. A. H. Thompson, professor of history in the University of Leeds, and member of the Royal Commission on Historical Monuments (England).

O.B.E.: Captain T. W. Barnard, director of the Barnard Institute of Radiology, Madras; Mr. T. R. Charlton, commissioner of lands, Crown surveyor, and chairman, Mining Board, Fiji; Mr. R. A. Farquharson, geologist in charge, Water-Boring Scheme, Somaliland Protectorate; Dr. R. S. G. Knight, manager and deputy superintendent, Royal Naval Cordite Factory, Holton Heath; Mr. F. Leney, lately curator, Norwich Castle Museum and Art Gallery; Mr. H. M. O Lester, deputy director, Sleeping Sickness Service, Nigeria; Mr. W. B. Rimmer, acting director of the Solar Observatory at Mount Stromlo, Commonwealth of Australia; Ram Chandra Srivastava, director of the Imperial Institute of Sugar Technology, Cawnpore, United Provinces, India; Dr. V. E. Wilkins, principal, Ministry of Agriculture and Fisheries. *M.B.E.:* Mr. J. Coutts, lately curator, Royal Botanic Gardens, Kew; Mr. W. A. Fyffe, public analyst for the Isle of Man; Mr. W. B. Mercer, agricultural organizer for Cheshire and principal of the Reaseheath Farm Institute; Mr. A. E. Spencer, computor, Land and Survey Department, Uganda. *Kaisar-i-Hind Gold Medal:* Dr. R. R. Stewart, principal of Gordon College, Rawalpindi, Punjab.

Indian Science Congress Association at Calcutta

THE twenty-fifth annual meeting of the Indian Science Congress Association, to which the British Association has sent a large delegation, opened at Calcutta on January 3 under the presidency of Sir James Jeans. Lord Rutherford was to have been president, and that portion of the address which he had prepared, representing his final word on what he used to describe as "the new alchemy", is printed on pp. 58–61 of this issue of NATURE. Sir James Jeans made his address brief, so that he might read to the assembled Congress a portion of that prepared by Lord Rutherford. In the first part of his address, Sir James paid eloquent tribute to the man whose place he was filling—"one of the greatest scientists of all time". He spoke of his greatness, his simplicity and sincerity, and remarked on his genius for friendship and good comradeship, an aspect of Rutherford's character which has also been demonstrated in the tributes to his memory we have been privileged to publish. In spite of the honours showered upon him, he was always "unassuming and ready to listen patiently to even the youngest and most inexperienced of his pupils or fellow-workers". Speaking of the work he accomplished, Sir James said that, "in his flair for the right line of approach to a problem, as well as in the simple directness of his methods of attack, he often reminds us of Faraday, but he had two great advantages which Faraday did not possess —first, exuberant bodily health and energy, and second, the opportunity and capacity to direct a band of enthusiastic co-workers. Great though Faraday's output of work was, it seems to me that to match Rutherford's work in quantity as well as in quality, we must go back to Newton".

Progress of Science in India

IN the second part of his address, Sir James Jeans referred to the progress of science during the quarter of a century since the Congress was founded, and to the contributions of Indian workers. Restricting himself to the field of mathematics and physics, he mentioned the remarkable discoveries made in pure mathematics by Ramanujan in his short life; the work of Sir Venkata Raman in sound and the theory of music, and his discovery of the spectral effect now known everywhere by his name; the investigations of Prof. M. Saha in astrophysics, "which gave us our first clear understanding of the meaning of stellar spectra, and so unlocked the road to vast new fields of astronomical knowledge"; and also the work of many Indians, especially Chandrasekhar and Kothari, on conditions in the interiors of stars. Many, other than mathematicians and physicists, would also be thinking of the great experimental skill of the late Sir Jagadis Chandra Bose. In 1911, Sir James said, there were no Indian-born fellows of the Royal Society; now there are four. In 1911, the Royal Society published no papers by Indians; in 1936, the Society published ten. The past twenty-five years have been one of the greatest periods in the history of science, a period of unprecedented progress in which India has taken its part and which has seen the remarkable growth of India as a scientific nation.

Policy and the Aborigines in Australia

IT is to be hoped that no apparent difference of opinion among anthropologists as to the ultimate fate of the Australian aborigines will be allowed to obscure the plain present duty of the Commonwealth Government in the matter of reform of policy and methods of administration. The report of Dr. Donald F. F. Thomson, research fellow of the University of Melbourne, to the Commonwealth Government on his observations as a special patrol officer for a period of fifteen months among the natives of Arnhem Land in the Northern Territories is uncompromising in its directness. He recommends, according to a dispatch of the Canberra correspondent of *The Times* in the issue of December 30, that the remains of the tribalized natives of the Northern Territories, who come under the control of the Commonwealth Govern-

ment, should be segregated in an inviolable reserve; and that legislation similar to that in force in New Guinea for the protection of natives should be imposed in their interest. Watering depots for pearlers on the coast of Arnhem Land should be abolished. The policy of administering native justice should be revised; the police should not be allowed to act as protectors; and special courts for the aborigines should be established. It is recommended further that the Commonwealth Government should set up a Department of Native Affairs under a trained protector and staffed by men trained to apply anthropological methods; while eventually the administration of native affairs throughout Australia should be brought under one control. The Arnhem Land natives should not be permitted to leave the reserve, and missions should be requested to remove their stations to the outskirts of the reserve to prevent the entry of outside influence.

SETTING aside the larger question of the unification of control of aboriginal affairs throughout Australia, for which much is to be said, Dr. Thomson's recommendations represent the absolute minimum of immediate and urgent reform essential for the preservation of the aborigines of the Northern Territories. Mr. McEwen, Commonwealth Minister of the Interior, is reported to have expressed the view that, as it is inevitable that sooner or later the aborigines must come into contact with civilization, they should be prepared for it. Apparently he accepts an opinion attributed to "some anthropologists" that the segregation of tribalized natives "is undesirable and impracticable". Without a more precise statement of its authority, such an opinion carries little conviction; and it is contrary to the views of anthropologists most competent to speak. How far segregation is practicable and likely to be beneficial depends upon the will of the Australian people to ensure that full effect shall be given to that policy, which past experience shows alone to be capable of affording the aboriginal an opportunity to survive. Segregation does not necessarily entail a state of stagnation in which the aboriginal tribe is a museum piece. When once conditions favourable, and indeed essential, to the continued existence of the aborigines have been secured, it will be possible to plan their future and guide development along lines consistent with their character and tradition.

Segregation in Polish Universities

NEARLY one thousand outstanding scholars in leading universities in the United States have signed an open letter to their colleagues in some of the universities of Poland, where Jewish students are now segregated from their fellows, and repeated acts of violence are reported against them and Jewish professors. It is realized that the university authorities are faced with great difficulties on account of religious and racial differences, but to bring these conditions of strife into the classrooms and laboratories by adoption of a policy of segregation violates the principle of intellectual freedom upon which university life must be based. "Such discrimination", the signatories protest, "seems to us alien to the spirit of academic freedom and of the free co-operation in the pursuit of knowledge that is so essential to the world of scholarship". The distinguished members of the faculties of Polish institutions of higher learning who have raised their voices against this discrimination will, it is hoped, be encouraged by this support of their American colleagues to continue their efforts to maintain the high tradition of such institutions in the free republic of scholarship. Sympathy with suffering, and sensitiveness to injustice, are attributes which distinguish man from all his fellow creatures; and any deliberate action which evokes them cannot be other than a reversion to primitive instincts. In this twentieth century it is depressing to see the law of the jungle being accepted and applied to secure racial and national domination, when such great powers and opportunities exist for the progressive evolution of man's higher nature. Those of us who believe in a nobler destiny for the human race than has yet been reached find a certain amount of comfort in the dismay expressed by American scholars at the extension to Poland of a spirit of intolerance foreign to every principle for which a university should stand.

Institute of Economic and Social Research

ANNOUNCEMENT is made of the formation of a new Institute of Economic and Social Research. Sir Josiah Stamp is to be the first president of the Institute, and Prof. N. F. Hall, professor of political economy in the University of London (University College), is to be director. Among the functions of the Institute are the carrying out of research, either by its own staff or by others temporarily associated with it, into the facts and problems of contemporary human society, and the publication of the results of researches, subject to adequate safeguards for the impartial and scientific character of these publications. Financial support for the Institute is being provided by the Sir Halley Stewart Trust, the trustees of the late Lord Leverhulme, the Pilgrim Trust and the Rockefeller Foundation. An annual income has been guaranteed of £10,000 for five years, and £5,000 for two years after. The offices of the Institute will be at 32 Gordon Square, London, W.C.1.

Physical Society's Exhibition

THE Catalogue of the Physical Society's Exhibition, held in the Imperial College of Science and Technology on January 4, 5 and 6, covers 226 pages, has many illustrations and is well arranged. The paging is on the bottom edge of the page, the number of the stall on the top outer corner and the name of firm exhibiting on the top inner corner. It is divided into two sections, Trade (177 pages) and Research (36 pages), and an alphabetical list of exhibitors in each section is provided which gives also the number of the stall. A four-page index of the instruments exhibited with indication of the pages on which they are described is also provided. Reference to the catalogue is therefore easy and quick. New exhibits are indicated in the catalogue by an asterisk and on

the stalls by a red star. As compared with last year, the exhibits in the Research Section have nearly doubled, while those in the Trade Section are about the same with a somewhat larger proportion of red stars. Some of the illustrations convey more information as to the working parts of the instruments than in past years, and are more useful to prospective buyers. Those on pp. 28, 165, 176 and 179 may be taken as examples. Discourses were delivered on January 4 by Captain G. C. C. Damant on "Diving in Deep Water and Shallow", on January 5 by Prof. A. F. C. Pollard on "Mechanical Amplification of Small Displacements" and by Sir Richard Gregory on "Science and Citizenship" jointly to the visitors to the Exhibition and to those attending the Exhibition of School Apparatus by the Science Masters' Association.

Engineering and Economics

IN an address to the Society of Engineers on October 4, entitled "Engineering and the New Economics", Dr. H. Chatley suggested that the engineer can contribute to the solution of economic problems of to-day in three ways. In the first place, the engineer can study the problem in terms of realities, such as goods, energy and services, and endeavour to disentangle them from the cobwebs of finance. Secondly, some engineers by entering politics can assist in spreading ideas on the realities of life. Thirdly, the engineer both by speech and by writing can help to explode some old fallacies and to educate the public in newer ideas and especially in that of the impartial application of scientific method to public affairs. Dr. Chatley illustrated his argument in respect of the last point by outlining in some detail the way in which the engineer can assist in the development of a sound fiscal policy in regard to coal and oil as well as in regard to the prevention of atmospheric pollution, the preservation of amenities, the question of values and prices, international debts, and population limits, and concluded by asserting that it is the duty of the engineer to understand the problems which have been raised by the misapplication by others of his skill. Scientific method should play an important part in citizenship since the classification of facts, the recognition of their sequence and significance and the habit of forming an unbiased judgment upon the facts which are characteristic of the scientific frame of mind are also essentials of good citizenship.

Awards for War Inventions

THE final report of the Royal Commission on Awards to Inventors, which has now been published (Cmd. 5594) shows that, in all, 1,834 applications were received by the Commission, of which 369 were dealt with by the Commission direct. Of the remaining 1,465, which were in the first instance considered by the Investigating Committee, 846 were withdrawn or apparently abandoned, 75 were referred to and later heard by the Commission and 544 were rejected by the Committee as having no reasonable chance of success. In 200 of them the claimant exercised his right of a personal appearance before the Investigating Committee. The total amount of awards was about £1,500,000, and a summary of the awards is appended to the report. Claims submitted to the Commission before the final date fixed by Royal Warrant (March 31, 1932) were virtually determined by December 31, 1933, but there were at that date certain claims the position of which had not been finally determined. The claims in question have since been otherwise disposed of, but while further sittings of the Commission were not necessary, the submission of a final report was delayed. The actual sittings of the Commission covered a period of fifteen years, and in that time the Commission lost by death its chairman, Lord Tomlin, as well as two members, Mr. A. C. Chapman and Prof. W. E. Dalby.

Commonwealth Fund Fellowships

THIRTY-FOUR of these fellowships, enabling British university men to devote two years to study and travel in the United States of America, are offered for award in 1938. Twenty-four are open to candidates of British descent, domiciled in the United Kingdom, who are graduates of universities therein, unmarried and less than thirty years of age; two to graduates of a university in a British dominion or colony; five are 'service fellowships' open only to candidates holding Government appointments in the British Empire over-seas; and three are Home Civil Service fellowships. The Committee of Award (chairman, Sir Walter H. Moberly) give primary consideration to intellectual ability, personality and initiative; account is also taken of character and health. Application, in the prescribed form, approved by the authorities of the college or university of which the candidate is or has been a member, must reach the Secretary to the Committee (35 Portman Square, W.1) by February 1. In 1937, awards were made to candidates from Cambridge (5), Cardiff, Glasgow, Liverpool (2), London (4), Manchester (2), Oxford (9), Reading, St. Andrews, New Zealand and South Africa. The subjects of study were very various, comprising: physics (3), chemistry (2), biophysics, zoology, physiology, medicine (2), engineering, architecture (2), law, political science, economics, international relations, education, modern languages, English literature, American literature, theology. The fellowships, in some respects complementary to the Rhodes scholarships, were established with the view of promoting mutual amity and understanding between Great Britain and the United States.

Constable's Portrayal of Weather

MR. L. C. W. Bonacina's paper on "John Constable's Centenary: His Position as a Painter of Weather" (*Quart. J. Roy. Meteor. Soc.*, October 1937) is a notable contribution to that affiliation of the Nature studies of the artist and scientific worker which is so much to be desired. The character of the country in which Constable was born and bred evidently influenced his practice of emphasizing cloud effects in landscape. The Suffolk countryside where the celebrated pictures of Flatford Mill, Dedham Mill and Stoke-by-Nayland were painted is the plain seen by the traveller on the London and North-Eastern Railway when

crossing the River Stour above Manningtree. Here the land presents none of those emphatic forms which in rugged scenery tend to concentrate attention on the lower half of the confronting hemisphere, so the eye ranges freely over the sky, and the cloud is as important as the field in the composition of the picture. Originals of Constable's paintings are readily accessible in the National Gallery and the Victoria and Albert Museum, and many are familiar as engravings, so that Mr. Bonacina's judgments can easily be tested. We welcome his conclusion that Constable's generalization of particular types of cloud in a manner not possible for photography is of service to the meteorologist. The analysis of certain pictures in which transitory forms are so perfectly depicted as to introduce a cinematic effect is a notable contribution to art criticism. It is indeed entirely appropriate that the student of natural science should thus contribute to the understanding of landscape painting, for the critical faculty is as a rule more highly developed in the man of science than in the artist—who does more than he knows.

A Guide to Fishes

REGULAR visitors to the Fish Gallery at the British Museum (Natural History) during recent years have watched with interest the rearrangement under the supervision of Mr. J. R. Norman. The large number of new casts and models, due to the skill of Mr. S. Stammwitz, have resulted in an exhibition illustrative of fish life that would be difficult to improve upon with present-day resources. The first part of the new guide to the Gallery contains a general account of classification, the scheme adopted being that proposed by Dr. C. Tate Regan (British Museum (Natural History). Illustrated Guide to the Fish Gallery. By J. R. Norman. Pp. x+175+6 plates. London: Trustees of the British Museum, 1937. 1*s.* 6*d.*). A wealth of interesting notes on habits and on fisheries turns what might otherwise be a rather dull catalogue into fascinating matter for general reading. The second and rather larger portion of the book is taken up with descriptions of the special exhibits, of which there are eighteen. These are evidently such as will cater for the needs of most visitors. They include such items as the crucifix fish, of interest to the credulous rather than to the serious student, who will find more to his taste in the section (and exhibit) devoted to breeding habits and development of coloration. This is an excellent guide book, but it is more than that; it is an elementary text-book of fish life. It is well written and well illustrated, in which connexion a word of praise must be spared for Lieut.-Col. W. P. C. Tenison's accurate and charmingly executed drawings.

The School Certificate Examination

THE School Certificate Examination, its merits and demerits and how it might be improved: these are matters which so closely concern so many people—parents and employers as well as school and university teachers and administrators—that the National Union of Teachers has performed an important public service in printing and circulating Sir Philip Hartog's address at its Portsmouth Conference. Sir Philip, than whom a more competent critic could scarcely be found, exposes manifold weaknesses of the examination as at present administered. He discusses such questions as: What does passing the examination imply in terms of what each successful candidate will be able to do? What do the examiners suppose they are trying to test? What of the validity and consistency of the test? More than a quarter of the candidates fail: does this not point to serious maladjustment between education and examination? He makes five definite proposals for reform: (i) classify tests in such a way as to show employers in what cases they can rely on a pass as showing the possession of definite utilizable skills; (ii) give to each candidate a certificate characterizing his or her performance in each subject; (iii) abolish the group system in so far as it hampers the school in determining the examination programme to suit each child after investigation of individual aptitudes; (iv) supplement the school certificate by a cumulative school record; (v) protect certain subjects, such as English literature, history and general science, from examination pressure, providing at the same time for their compulsory inclusion in the curriculum and school time-tables.

Gardens for Busy Enthusiasts

THERE must be a considerable body of garden enthusiasts who have only a limited time in which to maintain horticultural beauty around their homes. Professional cares of the specialist often diminish the hours of leisure which might be devoted to gardening, or other causes may intervene. Mr. R. S. Lynch's paper on "Gardens of Easy Maintenance" (*J. Roy. Hort. Soc.*, **62**, 9, 377–393, Sept. 1937) is a most useful help for such enthusiasts. Lawns are particularly insistent in their demands for attention, and for those who regard them as essential to garden beauty, Mr. Lynch has many suggestions for their more facile control. A pleasing arrangement of alpines upon a paved bank requires little attention, though it ministers well to formal artistry. The horticultural qualities of many perennial plants which demand neither pruning, frequent division, nor staking, are discussed in detail in the paper, whilst the claims of an evergreen garden are also considered. A large amount of practical information, which should help to meet a pressing modern need, is here portrayed.

Timber Seasoning in Australia

TIMBER seasoning has made very considerable progress in many countries of the world since the Great War. It was during that War that a great deal of research work in seasoning by means of kiln-drying was undertaken, more especially perhaps in Great Britain and in India. Owing to the enormous consumption of timber upon the War fronts all seasoned material was absorbed in a comparatively short space of time; and since then it is not an overstatement to say that good seasoned material of high quality is very difficult to obtain for many species of timbers. In this new departure of utilizing the kiln for drying

timbers, Australia has not been behind other parts of the Empire. In 1933 the Division of Forest Products of the Council for Scientific and Industrial Research published as a pamphlet Part 1 of "A Guide to the Seasoning of Australian Timbers", in which it was pointed out that timbers of different species frequently differ so widely in physical properties that it is impossible to prescribe a general set of conditions for air-drying or kiln-drying for all timbers, or even for all sizes of one timber. Part 2 of this Guide has been recently issued (Div. of For. Products, Pamphlet No. 68, Technical Paper, No. 22. Melbourne, 1937) written by W. L. Greenhill and A. J. Thomas. The work of determining suitable kiln schedules for various species and sizes of timber is being carried out in laboratory kilns, supplemented by information operated by the Queensland forest service. Based on the results of the work carried out since the publication of Part 1, seasoning notes and suggested schedules for twenty-two additional species are given in the present pamphlet.

Tuberculosis in the Far East

THE problem of tuberculosis was one of the subjects dealt with at the Conference of Far Eastern Countries on Rural Hygiene last August (League of Nations. Health Organisation. Report of the Intergovernmental Conference of Far-Eastern Countries on Rural Hygiene. Held at Bandoeng (Java), August, 1937. London: George Allen and Unwin, Ltd. 2*s*. 6*d*.). Tuberculosis is recognized as being one of the scourges in Eastern countries. Unfortunately, there is an almost complete absence of accurate data concerning the extent and severity of the disease in rural areas. The importance of carrying out preliminary surveys and sample tuberculin tests in the country is advocated. Financial limitations make it important that an anti-tuberculosis campaign should be simple and adapted to local conditions, and the gradual establishment of a network of rural dispensaries would appear advisable. The establishment of sanatoria, in the Western sense, would not seem to be applicable, but simpler institutions are suggested. A scheme for mass research on tuberculin sensitiveness was drafted.

Chinese Medicine and the Pangolin

The pangolin or scaly ant-eater (*Manis pentadactyla dalmanni*) is the most primitive of Chinese mammals, and although it is fully protected by law in the colony and island of Hong-Kong, the demand for its carcass makes more extensive protection in South China necessary (*Hong Kong Naturalist*, July 1937, 79). The animal itself is eaten, but a greater danger arises from the belief that the scales have medicinal value. Fresh scales are never used, but dried scales are roasted, ashed, cooked in oil, butter, vinegar, boy's urine, or roasted with earth or oyster-shells, to cure a variety of ills. Amongst these are excessive nervousness and hysterical crying in children, women possessed by devils and ogres, malarial fever and deafness. So much are pangolin scales in request for these purposes that yearly the scales from some 4,000 or 5,000 individuals were imported from Java, with a value of 3,700 guilders. But recent regulations in Java, which prohibit capturing and killing of pangolins and the export of scales, will turn the attention of the Chinese medicine men more forcibly towards the native product.

James Eights: a Pioneer Antarctic Naturalist

DR. W. T. CALMAN has done worthy service to the memory of an American naturalist of the early nineteenth century in his presidential address to the Linnean Society (*Proc. Linn. Soc.*, **149**, 171; 1937). The accuracy of the descriptions and drawings made by James Eights, his discovery of a ten-legged pycnogon (*Decolopoda*), in which no one believed until the rediscovery of the species by the Scottish National Antarctic Expedition almost seventy years later, his discovery of a new seal and a new dolphin, neither of which he named, his description of the breeding of the king penguin, and of the South Shetland Islands, all mark him as a naturalist of keen perception. It is unfortunate that the appearance of his descriptions in journals not readily accessible should have obscured and delayed the recognition of his merit, and more sad to learn that in his own country he dropped out of the current and lived for a quarter of a century, until his death in 1882, in loneliness, obscurity and poverty.

Spectrograms of Nova Herculis 1934

THE editors of the *Astrophysical Journal* in 1935 collected data as to the spectrograms of Nova Herculis 1934 available at different observatories, partly with a view to the ultimate production of an atlas showing the changes day by day in the spectrum of the star during the first few months after the initial outburst. On the appointment of a Nova Subcommission in the Commission of Stellar Spectra of the International Astronomical Union, this material was handed to Prof. F. J. M. Stratton as chairman of that Sub-commission. Further data as to the observational material available were secured, and now the spectrum of Nova Herculis for nearly every day is available from one source or another from the head of the Balmer series to $H\alpha$. The Solar Physics Committee at Cambridge has approved the production by the staff of the Solar Physics Observatory of an atlas showing daily changes over that range of spectrum. It is hoped to print the whole atlas on 16 stiff cards—one quarter of the spectrum on each card and one card for each month. The cost will depend on the number of subscribers to the atlas, and subscribers may be asked to pay as much as 25 shillings. If sufficient support is forthcoming, it is hoped to start work on the atlas early in 1938.

Rabies Prevention in India

DETAILS of the preventive treatment of rabies at the Pasteur Institute of India, Kasauli, are given in the thirty-fifth annual report for the year 1935 by the director, Dr. R. O. A. Smith. The total number of patients attending the Institute and its centres was 21,898, an increase of 657 patients as compared with the previous year, of whom 16,627 received the

complete course of treatment. There were 86 deaths among these, a percentage death-rate of 0·52, which compares with 0·49 for the previous year. In addition, 1260 courses of vaccine for the prophylactic treatment of animals were issued during the year. The vaccine employed is a carbolized 5 per cent emulsion of sheep's brain prepared from sheep infected with the Paris fixed virus.

Twenty-Five Years of Research in Dairying

TWENTY-FIVE years ago the National Institute for Research in Dairying, University of Reading, was founded, and to celebrate the event an "Anniversary Review", compiled by the staff of the Institute, has been issued. This booklet presents a short history of the origin and development of the Institute, with a brief account of its present relationship with the farm, the dairying industry generally and the public. A summary is also given of the many and varied investigations carried out at the Institute, or in collaboration with other research centres, mainly between 1923 and the commencement of the present year.

Announcements

PROF. RICHARD KUHN will deliver the sixth Pedler Lecture of the Chemical Society at the London School of Hygiene and Tropical Medicine on January 27 at 5.30 p.m. The subject of the lecture will be "Synthesis of Polyenes".

THE medical faculty of the University of Zurich has elected Dr. William Cortedge of Rochester, U.S.A., an honorary doctor in recognition of his work on applied physics in medicine especially in roentgenology.

THE Rockefeller Foundation of New York has decided to award Profs. A. Kluyve of Delft and L. S. Ornstein of Utrecht financial support for five years for their radiobiological investigations, which have already been supported by the Foundation for three years.

THE Women's Medical Association of New York City offers the Mary Putnam Jacobi Fellowship (1000 dollars for one year) which is available for post-graduate work in the medical sciences. The fellowship is open to any woman graduate of an approved medical school. Further information can be obtained from Dr. Phoebe Du Bois, 150 East 73rd Street, New York.

THE Ophthalmological Society of the United Kingdom has instituted a Treacher Collins Prize of £100, which will be awarded every three years for the best essay submitted on a subject selected by the Council. It will be open to medical practitioners of any nationality, but the essay must be in English. The first subject selected is cerebro-spinal disease and its relation to the optic nerve. Essays should be submitted to the honorary secretary, 5 Racquet Court, Fleet Street, E.C.4, before December 31, 1938.

DR. HERMANN WINTZ, professor of obstetrics and gynæcology at Erlangen, has been awarded the Carlos Heiser Medal by the International Commission of Radiologists and Roentgenologists.

AN Italian society of metaphysics has recently been founded in Rome with a presidential council consisting of Prof. Ferdinando Cazzamalli, Dr. Luigi R. Sanguineti, Prof. G. Schepia and Dr. Emilio Servado. Further information can be obtained from the secretary, Dr. L. R. Sanguineti, Via Serbelloni 2, Milan.

THE twenty-seventh Dutch Congress of Natural Science and Medicine will be held at Nymwegen on April 11–13, 1939, under the presidency of Prof. G. Holst of Eindhoven. Further information can be obtained from the general secretary, Dr. D. Coelingh, Bussum, Holland.

A LAW for the reorganization of the University of Brazil and construction of the University City at Rio de Janeiro recently passed the House of Deputies. The Federal Government is now in charge of the construction of the University City, which will include the faculties of philosophy, education, fine arts, engineering, mining and metallurgy, chemistry and pharmacy, law, politics and economy, agriculture, veterinary medicine and music. There will also be a hospital.

"PHOTOMICROGRAPHY with the Vickers Projection Microscope" is the title of a booklet published by Messrs. Cooke, Troughton and Simms, Ltd., Buckingham Works, York, the present makers of the instrument, which was originally designed and manufactured at the Erith Works of Messrs. Vickers-Armstrong, Ltd. The apparatus is fully described, together with the electrical equipment and instructions for assembly. The manner of using and maintenance are described, and chapters are devoted to the theory of the microscope and preparation of specimens. The booklet contains much information on the subject of photomicrography and the use of the microscope in steel works practice, apart from the Vickers instrument, and is fully illustrated.

ASSISTANCE in the selection of suitable scientific books for public libraries is always welcomed. We are glad to see, therefore, that Prof. B. W. Holman, who is a member of the Brentford Borough Council, has contributed to the January issue of the *Fordwick*—a quarterly list of books added to the Brentford and Chiswick Public Libraries—a short article on recent books on social and other non-technical aspects of science.

"T. LL. H." informs us that in his review of Sir Frederick Maurice's "Life of Lord Haldane", the date of the appointment of the Royal Commission (NATURE, Dec. 11, p. 989) should have been 1909, not 1907.

ERRATUM. In the last line but one of the letter by Dr. A. S. Parkes entitled "Terminology of Sex Hormones" in NATURE of January 1, p. 36, for "*thryotrophic*" read "*thyrotrophic*".

Letters to the Editor

The Editor does not hold himself responsible for opinions expressed by his correspondents. He cannot undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. *No notice is taken of anonymous communications.*

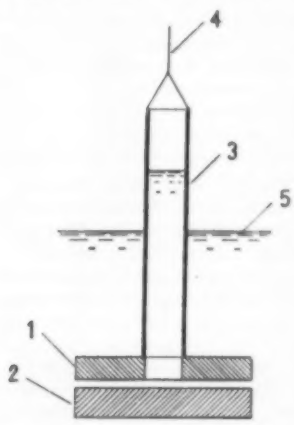
NOTES ON POINTS IN SOME OF THIS WEEK'S LETTERS APPEAR ON P. 83.

CORRESPONDENTS ARE INVITED TO ATTACH SIMILAR SUMMARIES TO THEIR COMMUNICATIONS.

Viscosity of Liquid Helium below the λ-Point

THE abnormally high heat conductivity of helium II below the λ-point, as first observed by Keesom, suggested to me the possibility of an explanation in terms of convection currents. This explanation would require helium II to have an abnormally low viscosity; at present, the only viscosity measurements on liquid helium have been made in Toronto[1], and showed that there is a drop in viscosity below the λ-point by a factor of 3 compared with liquid helium at normal pressure, and by a factor of 8 compared with the value just above the λ-point. In these experiments, however, no check was made to ensure that the motion was laminar, and not turbulent.

The important fact that liquid helium has a specific density ρ of about 0·15, not very different from that of an ordinary fluid, while its viscosity μ is very small comparable to that of a gas, makes its kinematic viscosity $\nu=\mu/\rho$ extraordinary small. Consequently when the liquid is in motion in an ordinary viscosimeter, the Reynolds number may become very high, while in order to keep the motion laminar, especially in the method used in Toronto, namely, the damping of an oscillating cylinder, the Reynolds number must be kept very low. This requirement was not fulfilled in the Toronto experiments, and the deduced value of viscosity thus refers to turbulent motion, and consequently may be higher by any amount than the real value.



The very small kinematic viscosity of liquid helium II thus makes it difficult to measure the viscosity. In an attempt to get laminar motion the following method (shown diagramatically in the accompanying illustration) was devised. The viscosity was measured by the pressure drop when the liquid flows through the gap between the disks 1 and 2; these disks were of glass and were optically flat, the gap between them being adjustable by mica distance pieces. The upper disk, 1, was 3 cm. in diameter with a central hole of 1·5 cm. diameter, over which a glass tube (3) was fixed. Lowering and raising this plunger in the liquid helium by means of the thread (4), the level of the liquid column in the tube 3 could be set above or below the level (5) of the liquid in the surrounding Dewar flask. The amount of flow and the pressure were deduced from the difference of the two levels, which was measured by cathetometer.

The results of the measurements were rather striking. When there were no distance pieces between the disks, and the plates 1 and 2 were brought into contact (by observation of optical fringes, their separation was estimated to be about half a micron), the flow of liquid above the λ-point could be only just detected over several minutes, while below the λ-point the liquid helium flowed quite easily, and the level in the tube 3 settled down in a few seconds. From the measurements we can conclude that the viscosity of helium II is at least 1,500 times smaller than that of helium I at normal pressure.

The experiments also showed that in the case of helium II, the pressure drop across the gap was proportional to the square of the velocity of flow, which means that the flow must have been turbulent. If, however, we calculate the viscosity, assuming the flow to have been laminar, we obtain a value of the order 10^{-9} C.G.S., which is evidently still only an upper limit to the true value. Using this estimate, the Reynolds number, even with such a small gap, comes out higher than 50,000, a value for which turbulence might indeed be expected.

We are making experiments in the hope of still further reducing the upper limit to the viscosity of liquid helium II, but the present upper limit (namely, 10^{-9} C.G.S.) is already very striking, since it is more than 10^4 times smaller than that of hydrogen gas (previously thought to be the fluid of least viscosity). The present limit is perhaps sufficient to suggest, by analogy with supraconductors, that the helium below the λ-point enters a special state which might be called a 'superfluid'.

As we have already mentioned, an abnormally low viscosity such as indicated by our experiments might indeed provide an explanation for the high thermal conductivity, and for the other anomalous properties observed by Allen, Peierls, and Uddin[2]. It is evidently possible that the turbulent motion, inevitably set up in the technical manipulation required in working with the liquid helium II, might on account of the great fluidity, not die out, even in the small capillary tubes in which the thermal conductivity was measured; such turbulence would transport heat extremely efficiently by convection.

P. KAPITZA.

Institute for Physical Problems,
Academy of Sciences,
Moscow.
Dec. 3.

[1] Burton, NATURE, **135**, 265 (1935); Wilhelm, Misener and Clark, *Proc. Roy. Soc.*, A, **151**, 342 (1935).
[2] NATURE, **140**, 62 (1937).

Flow of Liquid Helium II

A SURVEY of the various properties of liquid helium II has prompted us to investigate its viscosity more carefully. One of us[1] had previously deduced an upper limit of 10^{-8} c.g.s. units for the viscosity of helium II by measuring the damping of an oscillating cylinder. We had reached the same conclusion as Kapitza in the letter above; namely, that due to the high Reynolds number involved, the measurements probably represent non-laminar flow.

The present data were obtained from observations on the flow of liquid helium II through long capillaries. Two capillaries were used; the first had a circular bore of radius 0·05 cm. and length 130 cm. and drained a reservoir of 5·0 cm. diameter; the second was a thermometer capillary 93·5 cm. long and of elliptical cross-section with semi-axes 0·001 cm. and 0·002 cm., which was attached to a reservoir of 0·1 cm. diameter. The measurements were made by raising or lowering the reservoir with attached capillary so that the level of liquid helium in the reservoir was a centimetre or so above or below that of the surrounding liquid helium bath. The rate of change of level in the reservoir was then determined from the cathetometer eye-piece scale and a stop-watch; measurements were made until the levels became coincident. The data showing velocities of flow through the capillary and the corresponding pressure difference at the ends of the capillary are given in the accompanying table and plotted on a logarithmic scale in the diagram.

Capillary I		Capillary II			
$T=1·07°$ K.		$T=1·07°$ K.		$T=2·17°$ K.	
Velocity (cm./sec.)	Pressure (dynes)	Velocity (cm./sec.)	Pressure (dynes)	Velocity (cm./sec.)	Pressure (dynes)
13·9	183·5	8·35	402	0·837	36·6
11·5	154·5	6·92	218	0·757	31·3
10·3	127·7	6·88	143	0·715	26·1
9·0	105·0	6·30	101	0·685	21·1
8·2	83·5	6·05	56	0·655	16·4
7·5	65·7	5·55	30	0·609	12·1
6·9	49·3	4·70	11·3	0·570	8·3
6·1	34·1	4·39	9·2	0·525	4·3
5·2[2]	20·3	3·92	13·0	0·433	0·9
4·5[2]	15·2	2·88	7·2		

The following facts are evident:

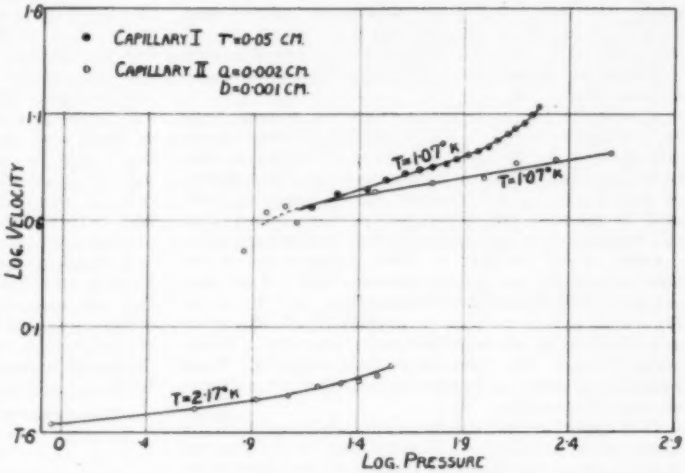
(*a*) The velocity of flow, q, changes only slightly for large changes in pressure head, p. For the smaller capillary, the relation is approximately $p \propto q^3$, but at the lowest velocities an even higher power seems indicated.

(*b*) The velocity of flow, for given pressure head and temperature, changes only slightly with a change of cross-section area of the order of 10^3.

(*c*) The velocity of flow, for given pressure head and given cross-section, changes by about a factor of 10 with a change of temperature from 1·07° K. to 2·17° K.

(*d*) With the larger capillary and slightly higher velocities of flow, the pressure-velocity relation is approximately $p \propto q^2$, with the power of q decreasing as the velocity is increased.

If, for the purpose of calculating a possible upper limit to the viscosity, we assume the formula for laminar flow, that is, $p \propto q$, we obtain the value $\eta = 4 \times 10^{-9}$ c.g.s. units. This agrees with the upper limit given by Kapitza who, using velocities of flow considerably higher than ours, has obtained



the relation $p \propto q^2$ and an upper limit to the viscosity of $\eta = 10^{-8}$ c.g.s. units.

The observed type of flow, however, in which the velocity becomes almost independent of pressure, most certainly cannot be treated as laminar or even as ordinary turbulent flow. Consequently any known formula cannot, from our data, give a value of the 'viscosity' which would have much meaning. It may be possible that the liquid helium II slips over the surface of the tube. In this case any flow method would be incapable of showing the 'viscous drag' of the liquid.

With regard to the suggestion that the high thermal conductivity of helium II might be explained by turbulence, we have calculated that the flow velocity necessary to transport all the heat input over the observed temperature gradient in the Allen, Peierls and Uddin experiments[2] is about 10^4 cm./sec. On the other hand, the greatest flow velocity produced by manipulation and by the pressure difference along the thermal conduction capillary will not be likely to be greater than 50 cm./sec. It seems, therefore, that undamped turbulent motion cannot account for an appreciable part of the high thermal conductivity which has been observed for helium II.

J. F. ALLEN.
A. D. MISENER.

Royal Society Mond Laboratory,
Cambridge.
Dec. 22.

[1] Burton, E. F., NATURE, 135, 265 (1935).
[2] Allen, Peierls and Uddin, NATURE, 140, 62 (1937).

Some Experiments at Radio Frequencies on Supraconductors

MEASUREMENTS were made on an extruded tin wire carrying an alternating current of a frequency of about 200 kilocycles per second superposed upon a direct current. The resulting magnetic field at the surface of the wire was thus caused to pulsate cyclically.

When the temperature of the wire was slightly below the transition temperature, the pulsation in field tended to carry the material through the transition between the normal resisting and the supraconducting states. It was found that under these conditions the potential difference between the ends of the specimen contained a component of double the frequency of the alternating current and of the magnitude to be expected if the resistivity of the material in the outer portion of the wire was able to follow the pulsations in the magnetic field without an appreciable lag.

The double-frequency component was present only in that narrow range of combinations of temperature and current for which a pulsation in resistance was to be expected. If there is any lag in the destruction of the supraconducting state by a magnetic field and in its re-establishment, it can be stated that the lags are small as compared with 2 micro-seconds.

Other measurements at radio frequencies up to 3,000 kilocycles per second indicate that for tin and tantalum the transition temperatures are the same for direct currents equal in magnitude to the root-mean-square of the high-frequency currents. When cooled below the transition temperatures, these materials offered no detectable resistance to currents of these frequencies.

It is expected that the more complete report of the work will appear in the February issue of the *Journal of Research of the National Bureau of Standards*.

F. B. SILSBEE.
National Bureau of Standards, F. G. BRICKWEDDE.
Washington, D.C. Dec. 3. R. B. SCOTT.

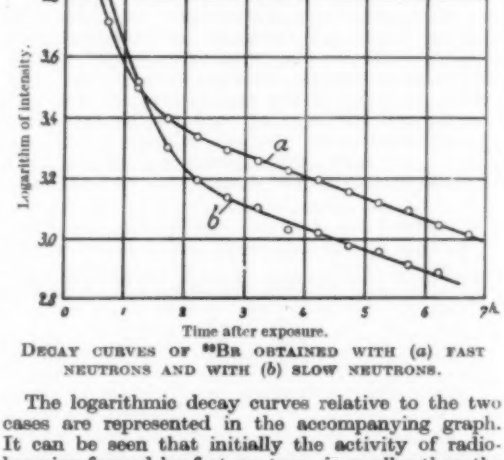
Isomeric Radio-Isotopes of Bromine

THE number of different radio-isotopes seems in several cases greater than can be explained by attributing to each of them a different mass-number. In particular, bromine irradiated with neutrons, γ-rays and deuterons gives four radio-isotopes (T = 7 min., 18 min., 250 min. and about 36 h.); and it seems that two of them, namely, the isotopes with T = 18 min. and T = 250 min., must have the same mass-number 80[1]. These facts, together with some others, have led several authors to assume the existence of isomeric nuclei.

Fleischmann[2] has recently investigated whether in the process (n, γ) the ratio of the two isomeric forms of ^{80}Br depends on the impinging neutron energy. He found that the resonance neutrons responsible for the formation of both isomers have the same absorption coefficient in boron, and concluded that the resonance levels of the compound nucleus leading to the two forms of ^{80}Br are identical. The ratio of equilibrium quantities of ^{80}Br (18 min.) and ^{80}Br (250 min.) is about 2·3 both for thermal and resonance neutrons.

As in this case the radio-isotopes are formed by neutron capture, it seemed to us of interest to investigate whether this ratio remains the same when the radioactivity is excited by the process (n, $2n$), that is, when the collision of a nucleus with a fast neutron results in the expulsion of two neutrons. In consequence we have irradiated bromine (a) with fast neutrons having energies up to 14×10^6 ev. produced by bombarding lithium with deuterons of 350 ekv., (b) with neutrons slowed down in a hydrogenated medium and originating from the same source or, alternatively, from a radon plus beryllium source. In both cases, the times of exposure and conditions of measurements were identical. During the runs the intensity and the voltage of the bombarding deuteron current were kept practically constant.

Bromine was exposed in the form of element; the irradiated bromine was transferred into a thin-walled glass vessel having the form of a cylindrical Dewar flask of 16 mm. inner diameter, which was put directly on a Geiger-Müller counter having brass walls of 0·05 mm. thickness. The activity was followed during 7 hours in order to determine exactly the ratio of the two isomers. It may be mentioned that in case (a) the activity obtained with a bombarding deuteron current of about 300 microamp. was so large that counting could be started only when the 7 min. product has practically decayed (about half an hour after the end of the exposure). The ratio of the initial number of impulses due to the two isomers and calculated for an infinitely long exposure was found in case (a) (process n, $2n$) equal to 0·56 and in case (b) (process n, γ) equal to about 2. Fleischmann has obtained a slightly higher value in this last case, but it must be remembered that the exact experimental value depends on the conditions of absorption of the two kinds of β-rays in the particular arrangement used, if their energy distributions are different.



DECAY CURVES OF ^{80}Br OBTAINED WITH (a) FAST NEUTRONS AND WITH (b) SLOW NEUTRONS.

The logarithmic decay curves relative to the two cases are represented in the accompanying graph. It can be seen that initially the activity of radio-bromine formed by fast neutrons is smaller than the activity due to slow neutrons; on the other hand, it is much larger on the subsequent part of the curves.

Process (a) consists in the expulsion of two neutrons from the excited compound nucleus, while in process (b) we have to do only with a γ-radiation. It would be of interest to see whether an intermediate value of the ratio Br (18 min.) : Br (250 min.) is obtained when the radio-isotopes are formed with expulsion of one neutron, that is, by irradiation with hard γ-rays.

A. SOLTAN.
Institute of Experimental Physics,
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L. WERTENSTEIN.
Mirosław Kernbaum Radiological Laboratory,
Warsaw Society of Sciences.
Nov. 24.

[1] Bothe, W., and Gentner, W., *Z. Phys.*, **106**, 236 (1937).
[2] Fleischmann, R., *Z. Phys.*, **107**, 205 (1937).

Formation of Lipin Phosphorus in Normal and Rachitic Rats, with a Radioactive Phosphorus Isotope as an Indicator

In previous papers[1,2] we communicated the results of some experiments on phosphorus metabolism in normal, rachitic, and rachitic rats treated with vitamin D, by which the distribution, absorption and re-excretion in relation to the deposition in bone of the active phosphorus administered were examined.

Significant differences between the three groups of rats could not be established. A very rapid entrance of the 'labelled' phosphorus into the bone was perceptible in all cases. Furthermore, it was observed that one hour after the injection into the tail vein, a considerable amount of the radioactive phosphorus was re-excreted into the small intestine, whereas the phosphorus within one hour had disappeared entirely from the blood in several rats.

We have now investigated the formation of lipin phosphorus after injection of inorganic phosphorus in six normal and rachitic rats. The 'labelled' phosphorus was administered as sodium phosphate in an aqueous solution of *p*H 6·4. For that purpose a fixed quantity of the radioactive solution was injected into the tail vein. A certain time after the injection of the active sodium phosphate—in this experiment after ½ and after 2 hours—the rats were decapitated and the blood was caught in a tared cup. The body and the head were immediately plunged into liquid air, then pulverized and kept in a frozen condition in solid carbon dioxide, until the chemical estimations were done and the preparations for the determination of the radioactivity were made.

The radioactivity was measured with an ionization chamber[3] in four preparations of each animal, namely, the blood, the total-phosphorus fraction, the lipin-phosphorus fraction and the remaining phosphorus fraction. In addition, the total phosphorus, the lipin phosphorus and the remaining phosphorus content of the whole rats were chemically estimated. The results of the determination of the radioactivity proved that almost the whole of the active phosphorus injected could be recovered. The figures for the radioactivity of the several phosphorus fractions, however, showed a large variation, so that a significant difference between the normal and rachitic rats could not be established.

We found, however, two facts of importance, which will be discussed in this letter; namely, the low radioactivity of the blood and the rapid formation of lipin phosphorus from the inorganic phosphorus of sodium phosphate.

In the first place, the blood figures confirmed our previous results; it was found that both within half an hour and two hours after the injection, the active phosphorus for the most part had disappeared from the blood. At most, 16 per cent of the injected phosphorus was still present in the whole blood.

A second interesting and unexpected fact was observed concerning the formation of lipin phosphorus. In earlier investigations, Artom[3] and his collaborators had shown that about nine hours after the ingestion of fat and radioactive phosphorus, comparatively large quantities of the active phosphorus were already found in the phospholipins of liver and gut of a rat. Hahn and Hevesy[4] showed that, in one hour after the subcutaneous injection of labelled sodium phosphate, labelled lecithin was already formed in the brain tissue of a fully grown rat. Now we were able to establish that both in normal and rachitic rats, within half an hour after the injection of the active phosphorus, a large amount was present in the phospholipins of the whole animal. Sometimes about 30 per cent of the active phosphorus injected was determined in the lipin phosphorus fraction.

Therefore, it is obvious that the formation of lipin phosphorus from inorganic phosphorus proceeds very rapidly. Whether this process is a real esterification by which the lipins are constantly broken down and rebuilt again under enzymatic action, or the process is only an exchange of organic phosphorus atoms of the lipins for inorganic phosphorus atoms of the sodium phosphate, must be left here undecided. We purpose to examine this question later. Though a detailed account of these and further experiments will be published elsewhere, we direct attention to the accompanying table, which proves the large individual variation in the figures for the blood and for the lipid fraction of the whole animal.

Rat	Interval after injection	Percentage of active phosphorus injected, found in:	
		Whole blood	Lipid fraction whole animal
	h. m.		
normal	0 30	0	27·5
normal	0 30	0	6·5
normal	0 30	15·5	11·2
rachitic	0 30	6·5	3·5
rachitic	0 30	10	14
rachitic	0 30	9·8	11·6
normal	2	0	24·5
normal	2	2·7	0
normal	2	8·3	10·5
rachitic	2	8	3·5
rachitic	2	15·2	5·5
rachitic	2	16·4	16

In our opinion, therefore, it is necessary to use a sufficiently large number of rats in each experiment.

Finally, we wish to express our thanks to Mr. J. C. de Back, Mr. J. Bouman, Mr. W. F. van Schalkwijk and Mr. G. J. van der Maas for their valuable assistance in this experiment.

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[3] NATURE, **139**, 836, 1105 (1937). *Arch. Intern. Physiol.*, **45**, 32 (1937).
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British Fisheries, Phosphate and the Solar Radiation Constant

In the autumn of 1921 there was a remarkable movement of water in the Atlantic, northwards and into the English Channel. This persisted into the early winter, and water temperature rose, though air and ground temperatures were falling[1]. No explanation has been given for this occurrence, nor has it happened since then to the same extent.

In 1923 the phosphate content of the water of the English Channel was determined, and it was shown that, late in the spring, this constituent became exhausted in the surface water, while the deeper water was much depleted. Lack of phosphate therefore limits the multiplication of the phytoplankton and so of animals also. In winter, when light is deficient, much phosphate is set free again. Such measurements were repeated for several years, and my analyses have been continued by Dr. L. H. N. Cooper. Since 1923, there has been a decrease in the winter phosphate maximum, with minor irregularities. At the start the concentration was 20 per cent above the average and in the 1934–35 winter it was 26 per cent below it.

It has been shown by Russell[2] that the young of summer-spawning fish show a great decrease over this period, and though the young of the spring-spawning fish began to decrease later, their decrease is now even more pronounced.

The shortage of fish can only be made good when our coastal waters again become enriched by phosphate; this depends upon the influx of water enriched by the mixing of deep Atlantic water over the continental shelf.

The explanation of the movement of such large masses of warmed water, moving apparently because they have been warmed more than usual, is one that postulates a great supply of energy. When going through the results of Dr. C. G. Abbot[3] of the Smithsonian Institution, the remarkable maximum in the solar content during the autumn of 1921, as shown by his curves, at once offered what appeared to be a rational explanation. These solar variations are made up of a number of cycles differing in period and intensity, and I am indebted to Dr. Abbot[4] for the information "that the solar radiation has not since 1920 and 1921 been so high for any considerable time as it was in those years. Nor has there been any such great fall in the solar constant as that of 1922". The fluctuation of individual days may show a range of 8 per cent[5], but more usually fluctuations are nearer 2 per cent. Terrestrial effects have been traced with still smaller variations.

The revised value[6] for the solar content of radiation is 1·933 calories (15° C.) per cm.^{2} per minute; this is the value outside the earth's atmosphere. The amount of heat reaching the surface of the ocean depends also on the absorption of the atmosphere, which on a large scale is itself dependent upon the amount of water which has been evaporated. The changes in the solar constant are only small percentages, but even small percentage changes may conceivably produce very large effects since the energy involved is so great.

In conclusion, it may be said that, while the relation between phosphate concentration and the abundance of the plankton each year is well established, the connexion between the abnormal movements of large masses of water and the solar constant of radiation is a reasonable speculation which is capable of being tested further in the future.

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Marine Biological Laboratory,
Plymouth. Dec. 8.

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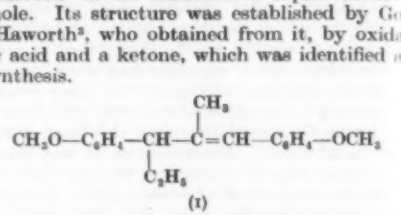
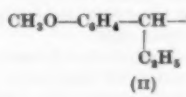
Œstrogenic Activity of Di-Anol, a Dimeride of *p*-Propenyl-Phenol

DI-ANETHOLE or iso-anethole (I) has been described by Kraut and Schlun[1] and later by Orndorff, Terrasse and Morton[2] as an unsaturated liquid dimeride of anethole. Its structure was established by Goodall and Haworth[3], who obtained from it, by oxidation, anisic acid and a ketone, which was identified as (II) by synthesis.



(I)

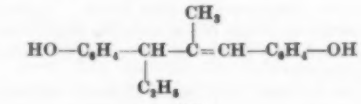


(II)

This di-anethole has œstrogenic properties, doses of 100 mgm. producing œstrus in three out of five castrated female rats. Demethylation was effected by heating with 2 parts potassium hydroxide and 4 parts alcohol at 190–200° C. for 16 hours. The product is a dark brown gum which is fully active in doses of 0·1 mgm. This crude product was boiled with acetic anhydride and the crude acetate distilled at 277–280° at 23 mm. and gave on analysis: C, 75·0; H, 6·9 per cent ($C_{22}H_{24}O_4$ requires: C, 75·0; H, 6·9 per cent).

The free phenol was recovered by hydrolysis and distilled at 264–266° at 20 mm. This was a pale yellow gum which darkened in contact with air. (Found: C, 79·6; H, 7·5 per cent; $C_{18}H_{20}O_2$ requires: C, 80·55; H, 7·5 per cent.)

This product, *di-anol*, in 100γ doses produced œstrus in 100 per cent of rats used, while 50γ doses gave a 60 per cent response. The acetate, which is perfectly stable in air, is fully active in doses of 200γ. No crystalline derivative has so far been prepared. The structure of this phenolic gum was shown to be (III) by methylation, and identification of the product as di-anethole (I). The dimethyl ether was oxidized by the method of Goodall and Haworth, yielding anisic acid and the ketone II.



(III)

An investigation is being made into the possible occurrence of this substance among the phenolic by-products produced from the preparation of anol (*p*-propenyl phenol)[4,5] by demethylating anethole with alcoholic potassium hydroxide at 200°.

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[1] Kraut and Schlun, *Jahresb.*, 552 (1863).
[2] Orndorff, Terrasse and Morton, *J. Amer. Chem. Soc.*, **19**, 859 (1897).
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Adrenal Cortex Differences in Male and Female Mice

THE sex difference in the adrenal cortex of mice, first described by Masui and Tamura[1] and later studied histologically and experimentally by Howard-Miller[2] and by Deanesly[3], has since been the subject of a number of publications[4,5,6]. Various far-reaching theories have been put forward, in spite of the fact that no other species so far studied shows the same histological distinction between male and female adrenals.

The essential difference, which can be first traced at the age of about five weeks, consists in the much greater development of the inner cortical zone in the young female mouse. Howard-Miller[2] introduced the term '*X*-zone' for this region of small, darkly staining, lipoid-free cells, to distinguish it from the zona reticularis common to males and older females, which is smaller in area and less sharply delimited from the rest of the cortex (Deanesly[3], Fig. 2–5). It was found that the *X*-zone degenerated rapidly in the middle of the first pregnancy and more gradually with age in the non-parous female. Its growth and degeneration are unaffected by ovariectomy. Castration, however, causes a well-developed *X*-zone to arise, concurrently with the enlargement of the adrenal, but this, like the *X*-zone of the female, gradually degenerates in older castrated animals.[7] Cramer[4], for reasons not found convincing by other workers[8], describes this transient zone as part of the medulla and not as part of the cortex.

It has now been shown[9,10] that the castration change in mouse adrenals can be readily inhibited or abolished by injections of androgenic extracts of urine or various synthetic male hormones, even of *trans*-androstenediol in amounts inadequate to cause growth of the seminal vesicles. These results support the view that the difference in the adrenals of the two sexes is entirely controlled by the secretions of the gonads.

On the other hand, a recent study of pituitary-deficient dwarf mice from a well-known genetic strain tends to throw doubt on this theory. The dwarfs, described by Smith and MacDowell[11] and Kemp and Marx[12], are homozygous for the recessive dwarfing factor and cease to grow at about 7·5 gm.; their adrenals, though small, are normal in appearance. Examination showed, however, that they are of the male type in both sexes, that is, the *X*-zone fails to develop in the female at any age, and the zona reticularis is restricted to a narrow band round the medulla. In view of this finding, the effects of castration on the dwarf mice were also investigated. Four male dwarfs aged 2–5 months were castrated and killed 15, 25, 30 and 42 days after castration. Slight enlargement of the adrenals were found, but no *X*-zone arose, although in the normal mouse this is well developed at four weeks after castration.

The absence of the *X*-zone suggests strongly that it is dependent on some secretion of the pituitary in which the dwarf mice are deficient, but the condition of their reproductive organs makes it unlikely that the gonadotrophic hormone is involved. As Smith and MacDowell[11] have pointed out, the gonads and accessory organs are by no means infantile in the dwarf mice, particularly in the males; spermatozoa may be formed in the testes, and the seminal vesicles undergo appreciable development. After castration, the latter show typical shrinkage.

The *X*-zone, as suggested in earlier work[3], seems to be essentially connected with adrenal growth, since it develops when the whole cortex is growing actively, as, for example, in normal prepubertal females, or in males after castration, especially after prepubertal castration. It is a transitory hyper-development of the inner cortex comparable to the zone which degenerates in the human adrenal after birth[2,3]. The fact that it regresses under the direct or indirect influence of male hormones provides no evidence in support of the theory advanced by Grollman[5] and Howard[6] that the *X*-zone is particularly associated with the known androgenic activity of the adrenal[13,14].

I am indebted to Dr. H. Grüneberg, Department of Genetics, University College, London, for a supply of the dwarf mice.

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Electric Impedance of Marine Egg Membranes

ALTERNATING current impedance measurements were made during the past summer on unfertilized and fertilized *Arbacia punctulata* eggs to determine whether or not an interpretation which has been given[1,2] for the low-frequency increase of capacity on fertilization is correct. The earlier data on *Hipponoë*[3] (*Tripneustes*) *esculentus* and *Arbacia*[1] egg suspensions showed the presence of two capacity elements, and it was suggested that the plasma membrane capacities of about 0·8 μf./cm.[2] remained unchanged on fertilization and that the fertilization membranes appeared with capacities of about 2 and 3 μf./cm.[2] respectively. The capacity element of the fertilized egg suspensions which was attributed to the plasma membrane has been much less pronounced in the recent measurements on both suspensions[4] and single eggs[5], and it has also been found, for both unfertilized and fertilized eggs, that the relatively non-conducting membrane lies either at or very close to the plasma membrane. Thus the increase in capacity on fertilization is probably due entirely to a change in the plasma membrane. It is possible that the second capacity element shown by the older measurements was due to unfertilized eggs in the fertilized suspensions.

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Delayed Mitosis and Chromatid Fusion

INVESTIGATIONS have been made with the seeds of several plants on the production of chromosome mutations through ageing[1,2]. With such material it is difficult, if not impossible, to separate the primary changes from any secondary ones which may follow them. It is, in fact, these primary changes which are of extreme importance for any theory of structural change.

The pollen of many plants is viable over long periods and the time of the pollen-tube (second post-meiotic) mitosis can be controlled directly by the time of germination. I have made an investigation of the changes induced by ageing on the pollen of *Pœonia Veitchii* ($n=5$) and *Kniphofia rufa* ($n=6$). The mature pollen was collected and stored at laboratory temperatures in a desiccator over anhydrous calcium chloride and germinated after varying intervals on Knop-sucrose solution to obtain the pollen-tube division. There was little, if any, decrease in the percentage germination over the period of the experiment.

I find evidence of a new kind of structural change in old pollen. Numerous chromatid bridges occur in cells without fragments. Fig. 1 illustrates the type of the changes. I observed only two instances of fragmentation in cells without bridges. There is a lag phase of two to three weeks before the changes begin to occur with appreciable frequency. A curve of bridge formation with time is given in Fig. 2 for *Kniphofia rufa*. The frequency distribution of the bridges, 0, 1, 2 or 3, in the individual nuclei of any one set of observations is very close to the binomial expected on random formation. There is thus no interference within the nucleus between bridge production in the separate chromosomes or chromosome arms. No interlocked types or other configurations which could only have been derived from two chromosomes, as Husted[3] noticed after X-ray breakage, have been found. We can only suppose that the bridges originate by union of the homologous

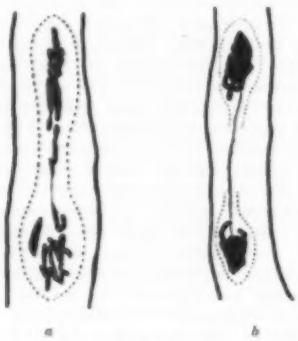

Fig. 1.

a: BRIDGE IN SHORT ARM OF CHROMOSOME IN 7 WEEKS OLD POLLEN OF *Kniphofia rufa*. THE BODY TO THE LEFT OF THE LOWER ANAPHASE GROUP IS A PERSISTENT NUCLEOLUS. ×1200. *b*: SINGLE BRIDGE IN 3 WEEKS OLD POLLEN OF *Pœonia Veitchii*. ×1200.

ends of the two sister chromatids derived by division from one parent chromosome. The same conclusion was reached by Upcott[4] from observations of similar bridges in the first post-meiotic mitosis in the immature pollen grain.

These findings reopen the questions which have been much discussed in the mechanics of structural change, as to the possibility of the union of chromosome ends and of the existence of a definite 'end-body' to the chromosome preventing such union[5]. They

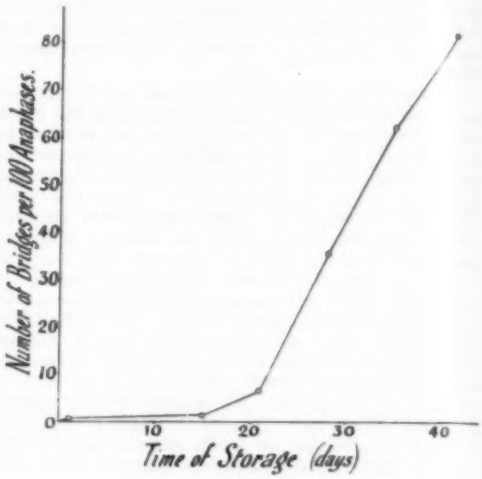

Fig. 2.

GRAPH SHOWING RELATION BETWEEN BRIDGE FORMATION AND TIME IN *Kniphofia rufa*.

suggest that the changes produced by age may obey different rules from those produced by X-ray treatment. Any general theory of structural change must take into account these differences.

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Osmosis in Physics and Biology

A MIXTURE was prepared containing lecithin and cholesterin (and beeswax) in a solution of ether; this mixture was imbibed (by vacuum) in the pores of a clay cylinder. This was dried and then filled with a molal solution of cane sugar and put in the same liquid; the solution was heated inside by an electric current and cooled outside by a water supply.

Water came out from the heated region against a pressure of 70 mm. mercury. This seems to offer an explanation of the mobilization of a liquid by living cells against the concentration gradient, and shows a possibility of using heat as a direct source of energy.

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Does Iron occur in the Solar Corona?

STRATTON[1] was able to recognize two 'forbidden' N II-lines in the beautiful photographs of the corona spectrum obtained by Sekiguti[1] at the total solar eclipse of June 19, 1936, and so to prove the occurrence of nitrogen in the solar corona. Moreover, Sekiguti noticed that two of the corona lines, λ 4815·9 and λ 5738·0, on his photographs came very close to the nebular lines λ 4814·78 and λ 5737 in the spectrum of η-Carinæ. One of these two lines (λ 4814·78) is amongst those which Merrill[2] recognized as 'forbidden' Fe II-lines. Should this identification be the correct one, this would mean that in addition to nitrogen another element, namely, iron, exists in the solar corona. In view of the interest generally taken in the chemical composition of the solar corona, we wish to discuss in some detail the possibility of such an identification.

It is strongly supported by the circumstance that λ 4814·78 is the strongest line of the multiplet to which it belongs. This is shown by the empirical evidence from the spectrum of η-Carinæ[2], which is supported by the following consideration: λ 4814·78 is due to the transition $3d^6\ (^3F)\ 4s\ {}^4F_{4\frac{1}{2}} \rightarrow 3d^7\ {}^4F_{4\frac{1}{2}}$, and is to be considered as an electric-quadrupole line. In the case of pure Russell-Saunders coupling, magnetic-dipole transitions occur exclusively between the fine structure components (levels) of an energy-term. Only if we take spin-orbit interaction into account (that is, at the same approximation at which intercombination lines appear) are magnetic-dipole transitions between the terms of the same electron configuration possible. As we are dealing in this case with a transition between two different electron configurations, it is only configuration interaction which can cause magnetic-dipole radiation. This, however, will be presumably negligibly small in comparison with electric-quadrupole radiation obtained already in zero order approximation. We can thus make use of the intensity formulæ for electric-quadrupole radiation in the case of pure Russell-Saunders coupling, which confirms the correctness of our statement that λ 4814·78 is the strongest line of the whole multiplet[3]. The intensity of the other lines of this multiplet is always less than about 40 per cent of the intensity of the line considered. As this is one of the faintest in the corona spectrum, the remaining lines of this multiplet can obviously not be visible on Sekiguti's photographs.

A very serious objection, however, against considering λ 4815·9 as a Fe II-line is the impossibility of tracing any other iron line in the corona spectrum, particularly those, the initial term of which is the same as that of λ 4814·78; for example, the intercombination line λ 4416·28, which is in the η-Carinæ spectrum nearly twice (9 : 4) as strong as λ 4814·78. Thus it is not quite justifiable to identify the corona line λ 4815·9 with λ 4814·78 in the spectrum of η-Carinæ unless additional evidence is obtained.

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[1] NATURE, **140**, 724 (1937).
[2] *Astrophys. J.*, **67**, 391 (1928).
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PROF. RUBINOWICZ has somewhat overstated my point of view in suggesting that a provisional identification of two forbidden lines of N II in the coronal spectrum proved the occurrence of nitrogen in the corona. He carefully safeguards himself from any claim that a suggested identification of one forbidden line of Fe II proves the presence of iron. But the case for iron is actually stronger than he has stated. The missing line, λ 4416·28, to which he refers, is a forbidden transition between two levels in the same electronic configuration; and a search by Dr. Dobbie and myself of the more likely transitions of this class, which might give lines in the region of spectrum available for study, has indeed failed to show any coronal lines. On the other hand, Prof. Tanaka's list of coronal lines[1] does show coincidences with two forbidden Fe II lines, λ 4244·0, $a\ {}^4F_{4\frac{1}{2}} - a\ {}^4G_{5\frac{1}{2}}$, and λ 5072·4, $a\ {}^4F_{4\frac{1}{2}} - a\ {}^4H_{4\frac{1}{2}}$, these lines, like Prof. Sekiguti's line λ 4814·5, $a\ {}^4F_{4\frac{1}{2}} - b\ {}^4F_{4\frac{1}{2}}$, all represent transitions from levels in the d^6s configuration to the lowest level of the d^7 configuration. The suggestion is that the conditions at this eclipse were favourable for the emission of forbidden lines of Fe II caused by transitions between two different electronic configurations; in such cases the transition probabilities for electric quadrupole radiation would be much higher than for magnetic dipole radiation.

The reality of faint lines observed but once in a coronal spectrum must remain uncertain. The stronger coronal lines, however, vary so much from eclipse to eclipse and from point to point in the corona that the very weak lines may well be irregularly present or absent. This provisional identification of forbidden lines does not touch the main corona spectrum but may serve as a pointer towards its ultimate identification.

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[1] *Proc. Phys. Math. Soc.* Japan, (iii), **19**, 93 (1937).

Adsorption of Constituents of a Solid Phase on the Surface

IT is a well-known fact that the concentration of alloying elements in the scale formed on heating an alloy in air differs in most cases considerably from the average composition of the material. The product of high-temperature oxidation of brass, for example, consists of zinc oxide only. At lower temperatures cuprous oxide is the prevailing constituent[1]. Iitaka and Miyake found nothing but BeO on the surface of copper-beryllium alloys containing so little as 1 per cent of beryllium. Copper-aluminium alloys with several per cent aluminium content, heated with a Bunsen burner, gave Al_2O_3 in places which had been embedded in the flame, while CuO was found on those parts of the surface which had been in contact with air[2].

Attempts at explaining these rather complicated phenomena were based chiefly on chemical arguments. The absence of copper oxide on brass, for example, was attributed to the reduction of cuprous oxide by zinc. Although the importance of secondary chemical reactions in some special cases can scarcely be contested, the accumulation of a constituent of an alloy on the surface can be explained in a quite general manner on a purely physical basis.

It was anticipated by J. W. Gibbs and J. J. Thomson and proved experimentally, that the tendency to reduce the free surface energy of a solution to a

minimum results in concentration of the constituent with the smallest surface tension on the surface[3]. Although there were *liquid* solutions which were concerned in these investigations, there is nothing in the argument which would prevent applying the conclusion to the state of equilibrium of a *solid* phase. If, following Desch[4], we assume as a tentative hypothesis that the values of the surface tension of solid metals are roughly proportional to those for the liquid state in the neighbourhood of the freezing point, we can arrange metals according to their surface tension in a following series:

Sb, Bi, Pb, Hg, Sn, Cd, Zn, Ag, Au, Cu;

the surface tension of antimony being the smallest, that of copper the greatest. As to the surface tension of other metals, no data are available. In any alloy the constituent preceding the others in this series should tend to accumulate on the surface. As the surface tension of metals is higher than that of any compound or non-metallic element, non-metallic constituents should also show a tendency to displace the metal from the surface. At ordinary temperatures the rate of diffusion is so small that it would take a very long time to reach the state of equilibrium; it is only when the diffusion is accelerated by high temperature or loosening the crystal texture by alternating stresses or polishing, that the effect is brought into prominence. The conclusion was confirmed by the following experiments:

A copper specimen containing 0·01 per cent of sulphur, etched in nitric acid, which had given the normal copper pattern on electron diffraction examination, was kept *in vacuo* for 4 hours at 800° C. After this treatment the covelline copper sulphide pattern has been obtained without any trace of copper rings. It shows that all the metallic copper has been displaced from the surface down to the depth of several tenths of an angström at least.

An etched bar from the same material was clamped in a lathe and rotated rapidly, while the free end was loaded. It was cooled all the time to prevent oxidation. On examination of a specimen cut from the part next to the chuck, it is found that copper sulphide has been formed on the surface.

A specimen burnished under benzene with an agate burnisher gave also the copper sulphide pattern. When using copper with 0·005 per cent sulphur content, copper sulphide rings were still clearly visible. Pure re-melted copper treated in a similar way yielded the usual diffuse pattern of polished copper.

A 98 per cent copper 2 per cent beryllium alloy burnished under benzene gave diffuse haloes, the spacings of which, 1·86 A. and 1·11 A., correspond, according to Prins's formula, to the size of beryllium atoms[5]. It points to the existence of a pure beryllium layer on the surface.

A 71/29 brass burnished under benzene and dipped afterwards in ammonium sulphide solution gave the wurzite zinc sulphide pattern. Apparently there is a thin layer of pure zinc on a polished brass surface.

These results throw fresh light on the problems of corrosion resistance of alloys, especially at high temperatures. Adsorption on the surface explains the protective action exercised by some constituents even if present in quite small quantities. An improvement which polishing produces in the corrosion-resisting properties of some stainless steels with low nickel content may be also interpreted from this point of view. The problem of bearing alloys is another field where this phenomenon may be expected to take an important role.

A more detailed account will be published in *Bull. Int. de l'Acad. Polonaise de Sci. et Lettres.*

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Viscosity of Air

RECENT determinations of the viscosity of air by Bond[1] (capillary tube method) and Kellstrom[2] (rotating cylinder) have yielded a value

$$\eta_{123^\circ\,\mathrm{C.}} = (1834{\cdot}8 \times 10^{-7})\ \text{C.G.S.}$$

Substituted in Millikan's data on the determination of e, this value gives

$$e = 4{\cdot}817 \times 10^{-10}\ \text{E.S.U.},$$

which is considerably higher than values of e obtained by other methods.

In conjunction with Dr. Bond, I commenced a fresh determination with several improvements in the apparatus. As a result of a large number of experiments on three different sets of tubes, I find

$$\eta_{11^\circ\,\mathrm{C.}} = (1800{\cdot}8 \pm 0{\cdot}7) \times 10^{-7}\ \text{C.G.S.}$$

My experimental value of the temperature coefficient is $4{\cdot}93 \times 10^{-7}$ per ° C., agreeing with the value found by Millikan[3]. Thus I obtain

$$\eta_{123^\circ\,\mathrm{C.}} = (1830{\cdot}3 \pm 0{\cdot}7) \times 10^{-7}\ \text{C.G.S.}$$

If this value is substituted in Millikan's oil drop data, the result is

$$e = (4{\cdot}800 \pm 0{\cdot}004) \times 10^{-10}\ \text{E.S.U.},$$

which is in very good agreement with the value of e deduced by von Friesen[4] from recent values by X-ray and electron diffraction methods.

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Dec. 6.

[1] Bond, W. N., *Proc. Phys. Soc.*, **49**, 205 (1937).
[2] Kellstrom, G., *Phil. Mag.*, **23**, 313 (1937).
[3] Millikan, R. A., *Ann. Phys.*, **41**, 759 (1913).
[4] von Friesen, *Proc. Roy. Soc.*, A, **160**, 424 (1937).

Pyrrolidone: a Chemical Group of Particular Significance to Differentiation

THE inquiry into whether or not the naturally occurring tissue components of general distribution play a part in developmental growth has brought out that each amino-acid and nucleic acid derivative has its own separate and peculiar effect upon the growth of *Obelia geniculata*[1].

Although the individuality is indubitable, certain compounds produce a like effect on differentiation expression when they are present singly in the culture solutions. Nicely enough, it is possible to trace a chemical relationship between these differentiation-forwarding substances other than the simple fact that they are composed of carbon, nitrogen, hydrogen and oxygen.

The differentiation-enhancing compounds are first, *d*-glutamic acid and its homologue *l*-aspartic, *l*-proline and *l*-hydroxyproline. The members of this group are interconvertible through pyrrolidone carboxylic acid, a common intermediary[2,3]. Then there is tyrosine, from which melanin is formed by tyrosinase through compounds identified as carrying the benzopyrrole ring[4]. Finally, differentiation is advanced by cytosine and thymine, two nucleic acid derivatives which carry the carbonyl-imid-methine sequence in heterocyclic configuration similar to pyrrolidone[5].

C—N—C
O H H

It is clear that the group of differentiation-forwarding compounds is united by the common possession of a potentiality for yielding a single and unique type of chemical configuration. The association is too close-knit to be fortuitous.

The assumption is therefore justified that in the pyrrolidone configuration or some part or derivative thereof is to be found that chemical constellation which is a specific determinant and participant in some phase of that chemical specialization which is differentiation, and through which cells are brought to their characterizing functionable and structural maturity.

The possible significance of this to neoplasia is clear—for through the application of the principle it is possible that cancer cells may be brought to maturity—if they can be so brought—and thus the lethal aspects of this growth be diverted. Work in this direction will be carried out.

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[1] Occasional publications of the American Association for The Advancement of Science, No. 4. June 1937. Pp. 167–172.
[2] Mitchell and Hamilton, "The Biochemistry of the Amino acids" (Chem. Catalog Co., New York, 1929).
[3] Weil-Malherbe and Krebs, *Biochem. J.*, **29**, 2077 (1935).
[4] Richter's "Organic Chemistry", **3** (Nordeman, N.Y., 1923).
[5] Levene and Bass, "Nucleic Acids" (Chem. Catalog Co., New York, 1931).

Points from Foregoing Letters

DR. P. KAPITZA describes new experiments from which he deduces that the viscosity of helium II (below the λ-point) is at least 1,500 times more than that of helium I at normal pressure, which may account for the abnormally high heat conductivity of helium II. He suggests that helium, below the λ-point, enters a special state that may be called super fluid. Further experiments are reported by J. F. Allen and A. D. Misener indicating that the flow of helium II at 1° K. does not follow the ordinary equation for laminar or turbulent motion. The authors consider that the type of motion observed might arise from slipping of helium II over the surface of the tube, in which case the flow method would not be likely to give a value of the viscosity which had much meaning, and that undamped turbulent motion cannot account for an appreciable part of the high thermal conductivity observed.

The potential difference between the end of a tin wire at the transition temperature (of supraconductivity) according to Dr. F. B. Silsbee, Dr. F. G. Brickwedde and R. B. Scott, contains a component of double the frequency of the alternating current (200 kc./sec.), when the last-mentioned is superposed upon a direct current, so that the resulting magnetic field at the surface of the wire is caused to pulsate cyclically.

Prof. A. Soltan and Prof. L. Wertenstein have found that the ratio of formation of the two radio-isotopes of bromine with half-lives 18 min. and 250 min. which, according to recent views, are considered as representing two isomeric forms of the nucleus ^{80}Br, is distinctly different when the radioactivity is excited with fast (up to 14×10^6 ev.) and slow (thermal and resonance) neutrons. This ratio is equal in the first case to 0·56 and in the second case to 2.

By injecting 'labelled' sodium phosphate into the tail vein of six normal and six rachitic rats, Dr. M. J. L. Dols and Prof. B. C. P. Jansen, in collaboration with Prof. G. J. Sizoo and F. Barendregt found that within half an hour a considerable amount of the inorganic phosphorus injected had been transformed into organic phosphorus of lipins. The blood figures confirmed their previous results; within half an hour after the injection, the active phosphorus had, for the most part, disappeared from the blood. Significant differences between normal and rachitic rats could not be established.

From changes observed since 1923, Dr. W. R. G. Atkins points out that the relation between phosphate concentration and the abundance of plankton in the water of the English Channel is well established. He suggests that there is also a connexion between the abnormal movement of large masses of water from the Atlantic Ocean to the Channel and the change in the amount of radiation from the sun.

Miss Ruth Deanesly reports that castration of young male dwarf mice does not enlarge the '*X*-zone' of the adrenal, a region of small, darkly stained, lipoid-free cells, found in the adrenal cortex of normal female mice, and also developing in normal castrated mice, unless counteracted by injections of male sex hormone. The new experiments indicate that the development of the '*X*-zone' is not controlled solely by secretion of the gonads but may be dependent upon some secretion of the pituitary in which the dwarf males are deficient.

H. N. Barber reports that chromatid bridges are induced by ageing in the second postmeiotic mitosis of pollen of *Pæonia* and *Kniphofia* species. They are probably formed by union of the homologous ends of the sister chromatids derived by division from one parent chromosome.

Prof. A. Rubinowicz notices that Prof. Sekiguti's identification of the coronal line λ 4815·9 with the nebular line λ 4814·78 in the spectrum of η-Carinæ would indicate the occurrence of iron in the solar corona. Although this identification appears to be partially justifiable, certainly further evidence for its support is needed. Prof. F. J. M. Stratton also discusses this identification.

Dr. S. Dobinski finds that the concentration of alloying elements in the neighbourhood of the surface is governed by the surface tension of the constituents and differs in most cases considerably from the average composition of the material. Electron diffraction experiments on some copper alloys confirm this view.

Research Items

Effect of the Medium on Radium-sensitivity of Cells

IN a communication addressed to the Editor, Dr. G. Harker, of the Cancer Research Committee, University of Sydney, describes the extension of his observations (NATURE, **137**, 190; 1936) on the inhibiting effect of radiation from radium plaques on the inversion of sucrose by living yeast cells, an effect now found also with X-radiation. If during irradiation with radium the cells are kept in suspension by gentle stirring, the inversion of sucrose is less than in the unstirred cells, although, owing to settling, the latter are much closer to the radium. The magnitude, and even the direction, of this effect are dependent on the neutral salt content of the medium. Since Loofbourow *et al.* (NATURE, **139**, 589; 1937) have shown that stimulating substances may be liberated from irradiated cells, Dr. Harker removed the aqueous suspension fluid by centrifuging the suspension of cells after 18 hours irradiation by 30 mgm. of radium, and re-suspended the cells in fresh sucrose. It was found that the passage of substances from the cells into the liquid increased inversion in both this and the non-irradiated control specimen, but the increase was greater in the irradiated one. When the cells were irradiated in 10 per cent sucrose solution with the same quantity of radium, after 5 hours exposure the extent of inversion by the re-suspended yeast was less than that of the control; after 18 hours it was greater. It is concluded that in the early stages stimulating, and in the later stages inhibiting, substances are given off into the solution by irradiated yeast cells, and that the solution in contact with the cells plays an important part in these effects.

Anatomy of the Ox

WHILE a considerable amount of work has been done on the dog and horse, so that the anatomy of these animals is now fairly well known, not nearly so much has been done on cattle. In a recent publication, H. N. Chelva Ayyangar (Imp. Council Agri. Research, Sci. Monograph No. 11, 1937) has provided a detailed account of the course, constitution and distribution of the nerves supplying the levator anguli scapuli and rhomboideus muscles and of the formation of the phrenic nerve in the ox. In the same monograph are included descriptions of forty-seven deviations from the normal course or constitution of various arteries and nerves in the same animal. Thirty-seven of these have already appeared separately, but are here gathered together. The monograph is fully illustrated by seventy-one diagrams or photographs of the actual dissections.

Biology of Rhodesian Diptera

THE attention of students of Diptera is directed to two papers by Mr. Alexander Cuthbertson (*Proc. and Trans. Rhodesia Sci. Assoc.*, **35**, August 1937). These articles deal with the biology of various Diptera inhabiting Rhodesia. In the first paper are given short accounts of the larva and pupa of *Solva* (Xylophagidæ) and of species of *Tabanus*, *Rhynchomyia* and *Tricylea*, which are also figured in the text. Three new species of Asilidæ are also described by Dr. E. O. Engel, of Munich, who collaborated with the author. In the second paper there are given biological notes and observations on various Diptera, including accounts of a number of species of Asilidæ and the prey which they had captured.

Sense Organs of Fishes

A CONDENSER-COUPLED five-stage amplifier, a Matthews's oscillograph, a loud-speaker and a delicate perfusion method were employed by A. Sand (*Proc. Roy. Soc.*, B, No. 833, Aug., 1937) to investigate the mechanism of the lateral sense organs of fishes. The types employed were the roach, the rudd, the plaice, the dogfish and three species of rays. The receptors of the lateral line system show a common mode of behaviour with those of the semicircular canals, which is perhaps not surprising when one takes into consideration the origin of the two sets of organs. Excitation is brought about by the movement of the fluid in the canal; that it is a fluid is demonstrated by the ease with which it can be utilized in perfusion. It is a system of great mechanical sensitivity and can appreciate tapping, made with a hammer on the table on which the specimen lies, that is too slight for perception with the hand. There is a spontaneous frequency of discharge from the individual end-organs, and a slow movement of the fluid in the canal produces a response over and above these. Over the greater portion of the range of stimulation the receptor organs obey the logarithmic law. The two directions of flow in the canal have contrary effects, that in one direction being excitatory and in the other inhibitory. The lateral-line sensory system is shown to be remarkably sensitive to low-frequency vibrations.

Polychætes from the Indian Ocean

THE Polychætes collected by the John Murray Expedition 1933–34 have yielded a high proportion of new forms. Mr. C. C. A. Monro, to whose care was allotted the task of describing the collection, has found it necessary to create one new genus, thirteen new species and four new varieties (John Murray Expedition 1933–34, Scientific Reports, **4**, No. 8, Polychæta, 1937). Several of these came from deep water, whence, indeed, much of the collection came. Of the new species may be mentioned a *Nereis* with remarkably long pedal languets and a *Eunice* with extremely long and highly pectinate gills. Some of the species taken were previously known from localities in parts of the world far removed from the Indian Ocean. Thus from 1519 metres and below in the Arabian Sea comes a specimen of the Magellan *Goniada eximia* Ehlers, and from the Gulf of Aden at 91 metres an example of *Chætozone setosa* Malmgren, the single specimen being inseparable from one of the same species taken at Spitsbergen. This *Chætozone* had not previously been recorded from tropical seas. These and some other similar records again emphasize the cosmopolitan distribution of many Polychætes, and form one of the most valuable features of this excellent report.

Ecology of Soil Fungi

FACTORS which govern the numbers of soil fungi are of vital importance for the maintenance of continued fertility. Investigations into the effects of manurial treatment, season and crop upon the quantity and quality of soil micro-organisms have not been numerous, but Dr. Jagjiwan Singh has recently published the results of such a research problem (*Ann. App. Biol.*, **24**, 1, 154–168, Feb. 1937). A direct correlation between soil fertility as measured by crop growth, and the number of fungi and Actinomycetes, has been established for two fields at the Rothamsted Experimental Station. Barn field, with permanent mangolds, and Broadbalk, with permanent wheat, are the two fields concerned. No dominant effect of the crop upon the soil micro-flora has been observed, nor can any effect of seasonal periodicity be claimed. Manurial treatments do not appear to induce specific fungal floras, though there was some evidence that *Penicillium* and *Dematium* species were more widely distributed in the Barn field, whilst *Fusarium* was most common in the permanent wheat land.

Long-range Weather Forecasting

SIR GILBERT WALKER has recently published an account of the methods adopted by the German Institute for Long-Range Weather Forecasting, under the directorship of F. Bauer, for its regular ten-day forecasts (*Quart. J. Roy. Meteorol. Soc.*, Oct. 1937). Statistical relationships connecting German weather with five-day means of pressure and temperature at distant centres of action are employed, also the method of studying the sequences of weather that followed the synoptic situations most resembling that of the forecast day; but apart from the thoroughness with which these parts of the work are done, there is nothing essentially novel about them. New ideas are, however, introduced in the conception of what may be translated as the 'broad-weather' situation—a condition of the atmosphere persisting for several days during which it controls the weather, being itself governed by conditions both in the troposphere and lower stratosphere. It has been found that the movements of regions of rising and falling surface pressure determined for a 24-hour interval, and defined by 24-hour isallobars, are usually almost completely in accordance with the gradient wind at a height of 5 km. and not with winds near the ground. At times, however, the 'steering' of the 24-hour isallobaric regions is by winds in the stratosphere, and that of the 3-hour isallobars by the winds of the lower troposphere. It has been found that the mean duration of a 'broad-weather' situation is 5½ days, and that their life-histories are closely connected with the formation and decay of 'highs' and 'lows' in the stratosphere. Since isallobaric systems most often move from some westerly point, this method would be less effective in British forecasting, where identification of the systems is hampered by paucity of observations to westward.

Rare Gases from the Hot Springs of Bath

OLDER examinations of the gases from Bath Springs had shown that these contained helium, argon and neon. The helium could be attributed to radioactive change and the argon might be derived from the atmosphere, but the reported presence of a large proportion of neon was unexplained, since this gas is less soluble than argon in water. M. W. Travers (*J. Chem. Soc.*, 1561; 1937) has analysed the gases from the King's Well and the Cross Spring and finds that the rare-gas fraction in each case consists of argon with about 12 per cent of helium and only 0·1 per cent of neon. The helium is certainly the product of radioactive change; the argon and neon are probably of atmospheric origin, the neon content being about half that in the atmosphere on account of its lower solubility. The gases from the springs were found to be free from oxygen but contained carbon dioxide; they contained about 13 c.c. of rare gas per litre. The rare gases were separated by means of fractionation by cooling.

Gypsum and Anhydrite

THE important transition temperature of gypsum and anhydrite: $CaSO_4 . 2H_2O \rightleftharpoons CaSO_4 + 2H_2O$, was given as 63·5° by van't Hoff and his co-workers and has been generally accepted. Very different temperatures have been reported by later experimenters. A. E. Hill (*J. Amer. Chem. Soc.*, **59**, 2242; 1937) has made a careful revision of this matter, particular attention being given to the attainment of equilibrium. It was known that anhydrite solutions could remain unsaturated or supersaturated for months, and hence an attempt was made to reach equilibrium from both directions, at 65°, 45° and 35°. From the solubility curves and previous data, it was found that a solubility curve could be drawn between the temperatures of 20° and 100° which was found to cut the well-authenticated curve for gypsum at 42°, which is the transition temperature. It will be seen that the new figure is about 20° lower than van't Hoff's figure of 63·5–66°. The usual difficulty of reaching equilibrium from the side of supersaturation was encountered.

Glide in Crystals

PROF. ANDRADE and his school are carrying out extensive work on the glide phenomena in strained single crystals. E. N. da C. Andrade and L. C. Tsien (*Proc. Roy. Soc.*, A, **163**, 1; 1937) have investigated slip in single crystals of sodium and potassium which belong to the body centred cubic system. Work on other metals which crystallize in this system shows that glide usually takes place in the [111] direction, but that the glide plane is not, as it generally is in other structures, the most closely packed plane. The sodium and potassium crystals were formed by cooling a tube of the molten metal progressively from one end, and were stretched under paraffin oil. The slip markings on the surface of the crystal were correlated with X-ray Laue diagrams of the crystal structure. The direction of glide was always very close to a [111] direction. The glide plane was (123) in these experiments, in which the angle between the axis of the wire and the 123 plane lay between 30° and 50°. Single crystals of molybdenum were prepared by a method in which a region of high temperature gradient was made to travel along a wire which was maintained at a high temperature (Andrade, *Proc. Roy. Soc.*, A, **163**, 16; 1937). The structure is body centred cubic, and experiments on the glide phenomena (L. C. Tsien and Y. S. Chow, *Proc. Roy. Soc.*, A, **163**, 19; 1937) show that the glide direction is [111]. The glide plane is different at different temperatures, being very near a (110) plane at 100° C., and a (112) plane at 300° and 20°. It appears that the gliding is not connected with the closeness of packing of the planes.

Limitations of High-Voltage Insulation

DR. WHITEHEAD, of Johns Hopkins University, communicates an interesting paper to the *Journal of the Franklin Institute* of September on the limitations of high voltage. Fifty years ago, it was thought that electrical transmission distances in America would never go much beyond 150 miles and that the economical voltage would not rise much above 110 kilovolts. The grounds for this opinion seem to have been that the distances between available sources of power, whether hydraulic or steam, were never greater than about 300 miles. At the present time, there are not many transmission systems for distances greater than 150 miles, but there are several working at 220 kilovolts. A conspicuous example is the Boulder Dam—Los Angeles transmission line over a distance of 300 miles at 287 kilovolts.

Calculation has shown the economic advantage of power development and transmission to greater distance at a higher voltage. Dr. Whitehead discusses the limitations placed on a further increase of transmission voltage by the insulating properties of the materials which are at present available. Those most commonly used are the atmospheric air, ceramic materials such as glass and porcelain, petroleum oils and various composite fibrous materials such as impregnated paper. The important electrical properties of the materials used for the insulation of high-voltage circuits are conductivity and electric strength. The conductivity measures the ability of the material to withstand slow leakage, and the electric strength measures its ability to withstand breakdown or actual failure and short circuit. All materials, including liquids and gases, have some electrical conductivity, but they vary over a very wide range, the conductivity of copper being 10^{20} times greater than that of a good mineral oil. Those with high insulating properties may vary a million times between themselves, but they are all classified as available for high-voltage insulation.

All the materials used for insulating high voltage must have high electric strength. Usually the overhead high-voltage transmission line depends on the atmospheric air for its insulation. The conductivity of the air is so small initially that it can be neglected. As there are always a few ions present, they move backwards and forwards under the forces exerted by alternating high voltage, and when they move fast enough they have collisions with neutral ions, thus creating new ions and increasing the conductivity of the air between the lines. This causes the well-known corona or brush discharge surrounding the conductors. The discharge increases the conductivity and energy loss in the air and is thus a limitation to its insulating properties. Up to the present, it has been found possible—notwithstanding the great increases in voltage values—by separating the conductors sufficiently and increasing their diameter, to prevent coronas from forming. In the Boulder Dam line the main conductors are hollow and 1·4 inch in diameter; they work at 285 kv. To get a corona the voltage would have to be increased to 450 kv.

It appears that the saving effected in conducting material at higher transmission voltages is partly offset by the increased cost of the insulation. The higher the voltage the greater the cost of the insulation and the construction of the line, as the minimum total cost must always determine the most economical value of voltage. We have reached a stage in raising voltage values where the physical dimensions of the line are so great as to be practically prohibitive. To meet these limitations, special forms of construction of the conductor system and special auxiliaries to the insulation system have become necessary, and these impose further limitations to increasing the voltage.

For these reasons, engineers are studying the use of underground cables for high voltages. There are now several installations at 132 kv. and a few at 220 kv. Some of these systems using 'oil-filled' cables have given satisfaction for more than seven years, and credit is due to the engineers in the experimental laboratories where they were developed.

Building Research*

A SPECIAL feature of the report of the Building Research Board for the year 1936 is the retrospect prepared by the Director, Dr. R. E. Stradling, reviewing the progress made during the eleven years since the Station was established in its present laboratory at Garston, Herts. For four years previously the organization was taking shape, and the value of the experience then gained may be judged from the progress made since 1925. The work of the Station goes ahead continuously and, in knowledge of materials and methods and in experience, considerable progress has been made, but it is seldom possible in any one year to chronicle any definite advance. Over the longer period the work can be seen in better perspective, the import of it becomes more evident and lines of future development are more clearly indicated.

For example, the Library begun primarily for internal service with a stock of two thousand items, has increased fully tenfold in size and has become a focal point for world-wide information regarding all matters appertaining to building. Its functions are not merely to stock all this material, but also to include its study and documentation for the promotion of research and assistance in inquiries. The fact that this work of the Library, its resources, and the kind of service it can provide are insufficiently well known outside, justifies special mention of them in detail, for, as the Director notes, there is no reason why

* Department of Scientific and Industrial Research. Report of the Building Research Board, with a Report of the Director of Building Research for the Year 1936. Pp. vi + 210 + 25 plates. (London: H.M. Stationery Office, 1937). 4s. net.

these services should not be equally available for the assistance of outside bodies as are those of the experimental and other facilities of the Station.

A branch of the work which has expanded rapidly during these years is that of dealing with technical inquiries. In the past year the number of inquiries received from architects for advice on the problem of sound transmission in buildings has been commented upon. On this subject investigation shows that the solution is primarily a matter of planning, as structural precautions can mitigate but not eliminate the discomfort of having noisy and quiet rooms adjacent. The report indicates that the most promising method of dealing with the transmission of noise in buildings is the provision of what is described as a 'floating floor'. The special investigations carried out in this branch also include those which are necessary to resolve difficulties or problems met with in practical operations, and the independent testing carried out for manufacturers of proprietary products. Reference is made to several of the most important or interesting of these in the report.

During the period a vast amount of work has been done on, and in connexion with, building materials —stone, brick, concrete, etc.—and the continuance of these activities is indicated. About those, their properties and limitations, much information has been obtained and made available for use. The investigations on bricks and brickmaking clays having been brought to a stage at which they can usefully be applied, attention is now being given to what is referred to as the efficiency of the brickwork structure as regards such matters as strength, permanency of bond, thermal insulation and exclusion of rain. In the cleaning of the exteriors of buildings the use of chemicals is condemned as destructive, and a process is recommended in which fine jets of water are employed for a period dependent on conditions, and this is followed by brushing. It is held that this gives satisfactory results without causing immediate or ulterior damage to the stone or even to carvings on it.

Among the major investigations made during the year were a series of tests to ascertain the resistance of I-beams of high tensile steel and of mild steel to failure by bend yielding of the flanges, by shear yielding of the web and by buckling of the web. Where necessary the surfaces were scraped and painted with a thin coating of plaster of Paris, the flaking of which indicated local yielding; this is clearly seen in the photographs taken during the tests. On behalf of the Ministry of Transport, tests were made during the year on six bridges; some particulars are given of these, but the data obtained have yet to be completely analysed. Three of the bridges were tested to destruction—a stone arch bridge of 21-ft. span built in 1793 collapsed under a load of 77·6 tons, a brick arch bridge of the same span and date failed at 123 tons, while one constructed in 1870 of cast iron beams and plates, with a span of 13 feet, broke under 74·6 tons, in each case the load being applied by hydraulic jacks at the centre of the span.

The record of work and results as set out here fully justify the Board in its statement that in this short period the Station has become a real factor in the building industry.

Eskimo Origins

THE essay on the origins of the most ancient civilization of the Eskimo, for which a prize was awarded by the Danish Government to Mr. Henry B. Collins, jun., in 1936, is now published under the title "Archæology of St. Lawrence Island, Alaska" (Smithsonian Misc. Collect., **96**, 1).

The essay takes as its starting point a descriptive account of the results achieved by the author and others in excavations on ancient sites in St. Lawrence Island, which established the succession *Old Bering-Punuk-modern Eskimo* in Western Eskimo culture. On the basis of this material it has been possible to make a detailed comparison not only of the elements of the two prehistoric and the modern cultures *inter se*, but also of this Western Eskimo culture, both as a whole and in each of its phases, with the other Eskimo groups, ancient and modern, including the Thule culture of Th. Matthiassen, the Caribou Eskimo of Kaj Birket Smith, and the Eastern Eskimo, as well as the neighbouring aboriginal peoples and cultures of America and north-eastern Asia.

In arriving at a series of general conclusions a number of problems come under consideration.

As regards the relation of the Western Eskimo and the Thule cultures, it has been demonstrated by Matthiassen that the Thule culture must have originated in the west along the Alaskan or Siberian coast, north of Bering Straits. This is now seen to be within the range of the Old Bering Sea and Punuk cultures; and on the basis of the St. Lawrence Island finds, it is shown that the Thule culture is more closely allied to Punuk of a late stage and the modern culture than to the Old Bering Sea culture. The Thule culture has also been shown to be close to the modern Point Barrow Eskimo. There is a close relationship between the Old Bering Sea culture and the prehistoric or Birnirk culture of old Point Barrow sites—the Birnirk culture, in fact, was, in part at least, contemporaneous with the old Bering Sea culture, while the modern Point Barrow is the closest to the Thule, possessing a number of important Thule elements, absent in the Birnirk culture.

This prominence of the Thule elements in modern northern Alaska is explained as due to a late return migration within the past few centuries of Thule Eskimo, after the original eastward spread of the Thule culture, which had developed out of the Birnirk, rather than the Old Bering Sea culture. This inference of a late migration westward is supported by the cultural, linguistic and physical uniformity of modern Eastern and Western Eskimo, while the physical characters of the modern Point Barrow Eskimo are quite distinct from the skeletal material from old Point Barrow sites.

The hypothesis that the north coast of Alaska has been subjected to a relatively late wave of migration from the east would serve to explain the view that the Eskimo had entered as a wedge at Bering Strait, breaking off earlier connexions between the

Palæo-asiatic tribes of Siberia and the Indian tribes of the north-west coast of America, for which the strongest evidence lies in their mythologies.

As to the place and cultural stage at which the Thule culture originated, indications, at present far from definite, point to a period late in the Birnirk cultural stage, which itself must be regarded as an outgrowth of the Old Bering Sea culture, but with an even closer relationship to Punuk. Sites intermediate between Birnirk and the oldest eastern Thule sites excavated by Matthiassen are much desired.

The weight of evidence is against the Aleutian Islands having served as a migration route from Asia to America. The known cultural remains of the Aleutians are of an essentially Eskimoid or American character, showing that the islands must have been peopled from the Alaskan mainland. It would have been no difficult undertaking for such expert navigators as the early Aleuts to push on to the Commander Islands and Kamchatka, while the reverse journey is improbable for Asiatics. The character of the American (Alaskan and North-West) affinities in Kamchadal and Koryak culture and mythology favour the southern route from America to Asia over the Aleutian chain.

Although on theoretical grounds we are forced to assume that man originally entered the American continent at Bering Strait, archæological work in this region has as yet revealed no trace of these earliest immigrants; nor has any trace of pre-Eskimo culture been found on St. Lawrence Island. It has, however, been shown that the Old Bering Sea culture of St. Lawrence Island is basic to existing phases of northern Eskimo culture from Siberia to Greenland. The bearing of the Alaskan investigations on the theory of a central origin of Eskimo culture is to show that the view put forward by Kaj Birket Smith of Caribou Eskimo culture as a form of proto-Eskimo is untenable, demanding as it does that this culture should have been static through a period of hundreds, or even thousands, of years, while everywhere else Eskimo culture was undergoing marked changes.

The existence of a number of elements in the Old Bering Sea culture, such as toggle-harpoons, sledges, kayak, etc., which are of widespread distribution in the Old World, but in the New World are found only among the Eskimo, points to an Old World origin for a culture which embodied the general features of Eskimo culture as we know it in its earliest western form; while certain indications suggest north-east Siberia, between the mouths of the Anadyr and Kolyma Rivers, as the area in which the Old Bering Sea culture in its specific form came into being.

Stimulation of Adventitious Root Formation by Chemicals

ON November 6, 1937, by invitation of the Director, a meeting to discuss the use of chemicals for stimulating the formation of roots on cuttings was held at the Royal Botanic Gardens, Kew. It is well known to botanists that, following the investigations on the Continent which led to the discovery, isolation and chemical identification of hormone-like substances controlling the growth of seedlings, these were found also to be capable of inducing the formation of adventitious roots. Since then, use has been made of β-indole-acetic acid and other synthetically produced substances in the hope that their application in aqueous solutions either directly in jars or by watering the compost would induce the formation of roots on cuttings. It would be of great value to horticulturists if cuttings of plants which do not 'strike' easily could be stimulated to do so in this way, or if the rooting of moderately easy subjects which are cultivated on a very large scale could be accelerated.

It is evident that an authoritative opinion concerning the practical value of these substances can be formed only as a result of co-operation between botanists, practical horticulturists and those who manufacture the chemicals. For this reason, those interested in the subject from these points of view were invited to the meeting at Kew. That interest in the subject is widespread may be judged from the ready response which was received to the invitation.

An unfortunate fact is that those plants which present most difficulty to experienced cultivators are in most instances precisely those which show least response to the application of chemicals that induce root formation. The degree of response exhibited by other plants appears to be more or less proportional to the ease with which they root without special treatment, the easiest subjects reacting with greater facility than the more difficult ones. So far as can be judged at present, the greatest hope for the practical utility of root-promoting substances will be in accelerating the rooting of woody cuttings of plants of 'medium' difficulty, as well as cuttings of herbaceous plants such as chrysanthemums which, although easy to propagate without special treatment, are cultivated on a very large scale. The production of a root system at the earliest possible moment is of great importance to nurserymen, especially with the latter type of material.

It will be appreciated that in the present state of knowledge the use of these substances is far from being a panacea for all propagating difficulties. Nearly everyone who spoke stressed the fact that the amount of experimental work which has hitherto been carried out on the practical application of these substances is too small to permit judgment on them to be passed. The fundamental physiological processes on which their activity depends are not at present understood at all. It has been known for many years that very dilute acetic acid possesses root-promoting properties, and its use has often been recommended to horticulturists. A point which needs elucidation is whether in fact the more complex root-promoting substances which have now come into prominence are superior to acetic acid. The small amount of experimental work to test this point which has so far been carried out rather indicates that they are, but the matter is by no means clear.

In view of the economic importance of the subject and the very varied experience necessary for assessing the value of various researches which are being or may be carried out on this subject in the future, a

small committee of scientific workers and horticulturists is being set up, with headquarters at Kew, to discuss the practical value of the results obtained. It is hoped that the committee may serve as a medium for the exchange of ideas, and also as a body which may be consulted by those who are working at isolated centres and are not in a position to decide in what directions their researches might most usefully be carried out. If at any time it is felt that further open meetings could usefully be held, the committee will decide where and when these might take place.

University Events

CAMBRIDGE.—The title of Stokes lecturer in mathematics has been conferred on Dr. S. Goldstein.

The Vice-Chancellor gives notice that the Cavendish professorship of experimental physics is vacant by the death of Lord Rutherford. A meeting of the electors will be held on February 11. If a proposal which is at present before the University is approved, the stipend of the professor will be £1,400 a year or while the professor holds a fellowship of a College with dividend £1,200, in addition to a non-pensionable payment of £200 a year for administration. Candidates for the professorship are requested to communicate with the Vice-Chancellor, and to send him on or before February 1 ten copies of any statement or testimonial which they desire to submit to the electors. If testimonials and references are sent they should not, taken together, exceed four in number.

The Adam Smith Prize is awarded to S. R. Dennison of Trinity College.

OXFORD.—S. J. Wright, for some years assistant-director and recently acting-director of the Institute for Research in Agricultural Engineering, has been appointed director.

Dr. J. R. Raeburn has been appointed a research officer under the Committee for Rural Economy.

A. G. Ogston has been elected to a fellowship at Balliol College for work in the biological sciences.

Dr. A. G. Gibson, Nuffield reader in morbid anatomy, has been elected to a professorial fellowship at Merton College.

Viscount Cecil of Chelwood has been appointed Romanes Lecturer for 1938.

The numbers of those reading the various main subjects of study in the academic year 1936–37 have recently been compiled. The largest science 'schools' are chemistry (207), physiology (194) and mathematics (143). Then come the new school of geography (100), agriculture and forestry (76), physics (59), zoology (40), engineering, botany and geology. About nine per cent of those reading these subjects are women. These numbers are greater than the corresponding numbers of the last survey. They are still small, however, compared with those of many other subjects. History (931), 'Greats', philosophy, politics and economics, and modern languages have each more than twice as many students as chemistry. Then come, in descending order of numbers, law (405), English, theology, music and Oriental studies.

SHEFFIELD.—The following appointments have recently been made: R. W. John, to be research assistant to the Department of Pathology; Douglas Harrison, to be assistant lecturer in electrical engineering; Donald Havenhand, to be assistant lecturer in metallurgy.

Science News a Century Ago

An Ascent of the Peak of Demawund

AT a meeting of the Royal Geographical Society held on January 8, 1838, extracts were read from three communications. One of these was an account of an ascent of the peak of Demawund in September 1837 by Taylor Thomson, the paper being presented by W. F. Ainsworth (1807–96), who had been surgeon and geologist to the Euphrates expedition of Colonel Chesney. The mountain, it was stated, was about 40 miles east-north-east of Teheran and previously there had been no account of its ascent by a European or any measurement of its height. Thomson left Teheran on September 4, and after obtaining guides at a village, ascended to the summit on September 9 and spent the night there in a cave which was heated to upwards of 76° F. by the sulphurous vapour which issued from the rocks. The geological formation of the mountain, from Gernah upwards for about 1,000 feet seemed, said Thomson, to be a bed of sandstone of the coal formation, with one seam of coal; above this limestone occurred with a thickness of about 1,200 feet, then came greenstone coloured with iron to within 100 ft. of the summit, which was a deposit of pure sulphur. "The geological results of this expedition," said Ainsworth, "possess great interest by establishing the existence of a pseudo-volcano in these central districts of Western Asia, and ally themselves with the observations which Baron Humboldt has made upon the evidences of volcanic action, which he has traced everywhere on the great continent of Asia. It is a remarkable fact that throughout those districts of Taurus, Amanus, Kúrdistán and the Persian Apennines, in which I have travelled, I have never yet met with rocks of the secondary series. The absence of every member between the chalk and the primary formations is one of the most remarkable features in the geology of Western Asia."

Fossil Discoveries in France

ON January 13, 1838, the *Athenæum* again directed attention to the recent discoveries of fossils in a French mine, remarking that "Further inspection increases the importance of the discoveries of M. Lartet and others . . . and fresh arrivals from him at the Academy of Sciences in Paris, produce new wonders. They combine the remains of animals, which, in all probability, no longer exist in nature, with some which do not appear to differ from those actually in being: the mine is still far from being exhausted, and a more favourable opportunity for the observations of geologists never before presented itself. The bones of the rhinoceros most abound; after these come those of deer, with their horns, and if an estimation may be formed by their size, the remains of a small and elegant species of ass or horse must have been deposited. New fragments of *macrotherium gigans* have come to light, which show that its claws bore a strong analogy to those of the Oryceteropus. The bears must have been totally different from any yet discovered; and those bones which belong to an animal called Amphicyon, by M. Lartet, show a strong analogy between it and the dog".

Samuel Woodward, 1790–1838

ON January 14, 1838, Samuel Woodward, the Norwich geologist and antiquary, died at the age of forty-seven years. Born in Norwich on October 2,

1790, he was the only son of a bombasine weaver. His father died in 1795, and at the age of seven years he was placed with a shawl weaver, but from the age of fourteen for ten years he worked with a manufacturer of bombasines and camelots. His taste for reading was stimulated by his employer, and he became a teacher in both evening and Sunday schools. In 1814 he obtained a clerk's place in the Norwich Union Fire Office, and in 1820 a similar post in Gurney's (now Barclay's) Bank at Norwich and this he retained for the remainder of his life. Devoting his leizure to the study of the history of his native county, he wrote on its churches, its antiquities and its geology. In 1830 he published "A Synoptical Table of British Organic Remains" in which for the first time all the known British fossils were enumerated, and in 1833 his work "An Outline of the Geology of Norfolk". One of his sons, Bernard Bolingbroke Woodward (1816–69), became librarian in ordinary to Queen Victoria at Windsor Castle, and another, Samuel Pickworth Woodward (1821–65), in 1845 became the first professor of geology and natural history at the Royal Agricultural College, Cirencester, and from 1848 until his death was an assistant in the department of geology and mineralogy of the British Museum.

Societies and Academies

Edinburgh

Royal Society of Edinburgh, December 6.

H. J. BHABHA: Production of electron showers by cosmic rays. Blackett and Occhialini showed in 1932 that cosmic rays produce showers. The quantum theory is capable of explaining these showers. Very high energy electrons lose practically their whole energy by emitting a few high energy quanta. Each high energy quantum is chiefly absorbed by the creation of a pair of positive and negative electrons. When, therefore, a very high energy electron passes through matter, it emits a few hard quanta, each of which in turn produces an electron pair, which again emit quanta and so on. Thus, if the initial energy be high enough, many hundred particles may be created, forming a shower.

R. S. BARCLAY and W. O. KERMACK: The decline of the birth-rate: regularities revealed by an analysis of the rates observed in certain European countries. An analysis of the birth-rates in Sweden, Denmark and Finland has been made by a method analogous to that previously employed by Kermack, McKendrick and McKinley in connexion with the death-rates of Scotland, England and Wales, and Sweden. As in the latter case, regularities of a somewhat simple type are revealed. The results are applied in the calculation of specific fertility rates for England and Wales for the past six decades.

J. SMALL: Quantitative evolution (4, 5 and 6). (4) The effect (K) of an organismal factor depresses the apparent Dp-ages of Compositæ in direct proportion to time. This rectilinearity indicates that species in Compositæ have a limited life-time, and that genera are similar. (5) The K values give 'free' Dp-ages which do not depart significantly from a rectilinear series in time. (6) The Dp-age unit is 2 million years for angiosperms. Their normal species life-time is 12 million years, with generic life-times at 24 million years. Consequential data are given for residual doubling in numbers, also present rates for origins and extinctions. It is concluded that the presence or absence of eliminative natural selection is a matter for statistical inquiry.

T. M. MACROBERT: Induction proofs of the relations between certain asymptotic expansions and corresponding generalized hypergeometric functions. The formulæ are established for simple cases by contour integration, and are then deduced for the general cases by induction. They are then employed to evaluate integrals involving Legendre functions and hypergeometric functions.

Paris

Academy of Sciences, November 22 (*C.R.*, 206, 941–1020).

CLAUDE CHABAUTY: The units of a body of algebraical numbers which are submitted to algebraic conditions.

PAUL VINCENSINI: A characteristic property of conformal transformations of the plane.

FERNAND AIMOND: Some properties of surfaces deduced from the conditions of equilibrium of convex surfaces.

MARCEL DECUYPER: Series of Laplace any four consecutive radii of which form a quadrilateral.

A. P. DIETZMANN: Infinite groups.

ARMAND RAUCH: Certain integral functions of the order $\rho < 1/2$.

ALEXANDRE FAVRE: The study of the Toussaint-Carafoli hydrodynamic tunnel with the view of obtaining bidimensional movements. Flow with circulation.

ROBERT SILBER: The influence of the blast from the propelling screw on the carrying power of an aeroplane, and the method to be followed for utilizing the results of tests of carrying power of a wing submitted to an air current from a screw.

PAUL MULLER: A new double image astronomical micrometer. A modification of the method used in the Rochon telescope. The instrument has been in use in the 16 cm. equatorial of the Strasbourg Observatory since January 1937, and has proved satisfactory.

JEAN MERCIER and JEAN DUBOIS: Contribution to the study of solid friction. Preliminary studies on the variation of the coefficient of friction caused by changes in the pressure and the velocity.

P. L. VIOLLE: Concerning Dewar flasks. The earliest description of a high vacuum and silvered surface in a glass flask for the purpose of reducing radiation appears to be that of J. Violle in 1882.

HENRI MOREAU: A preliminary study of precision mercury thermometers in fused quartz.

LEONID GABRILOVITCH: Sorting waves by periodically variable resistance systems.

WILFRIED HELLER: The influence of the size of colloidal particles on their optical anisotropy.

MAURICE COTTE: The orthogonal systems of electronic optics and their application to spectroscopy.

PIERRE BARCHEWITZ: The (CH) absorption bands of saturated and ethylene hydrocarbons between 6000 and 9500 A.

MAURICE LAMBREY: New observations on the disengagement of nitric oxide by various nitrated products at a low temperature. From a study of the gases evolved from crystallized tetranitropentaerythrite, it would appear that the true decomposition velocity is not measurable below a temperature

of 50° C. This conclusion is confirmed by applying the same method to nitrocellulose powders stabilized with diphenylamine.

EDOUARD RENCKER: Dilatometric researches on tempering and annealing of boric anhydride glass.

C. ZENGHELIS and EL. STATHIS: The formation of colloids by hydrogen. Salts of gold, silver, platinum and palladium are readily reduced by zinc in acid solution or by aluminium in alkaline solution; but the reduced metals are not colloidal. By the addition of a little gum to such solutions the metals are readily produced in a stable colloidal condition.

ANDRÉ BOROCCO: The comparative study of the dissociation pressures of sodium and potassium hydrides and deuterides. Measurements made by a differential method show that the deuterides have higher dissociation pressures than the corresponding hydrides.

MARTIAL FÉLIX TABOURY and ELIE GRAY: The corrosion of zinc in distilled water alone or in the presence of a gaseous atmosphere.

SIEGFRIED HALBERSTADT: The exact conditions of the formation of the compound of tungstic acid and 8-oxyquinoline. The precipitation is quantitative when the *p*H of the solution is 3·5: in the presence of phosphoric acid, none of the latter is coprecipitated.

CHARLES COURTOT and ANDRÉ BERNANOSE: Phenomena of chemico-luminescence, in the visible spectrum, of molecules containing the amide group.

DANIEL BODROUX and RENÉ THOMASSIN: Syntheses of paracyclohexylbenzylic aldehyde and of paracyclohexylbenzoic acid.

ANTOINE WILLEMART: Homologues of paraanthracene: polymers of 9-methylanthracene and of 9-ethylanthracene.

JEAN KANDEL: The catalytic hydrogenation of β-ionone: dihydro-β-ionone, dihydro-β-ionol. Some derivatives of α- and β-ionol.

PAUL GAUBERT: Liquid crystals obtained by sublimation.

PIERRE BELLAIR: The sandy formations of eastern lower Provence.

GEORGES DÉJARDIN and ALBERT ARNULF: The ultra-violet absorption spectrum of atmospheric ozone. Except for the effect of temperature, there is no appreciable difference of structure between the spectrum of atmospheric ozone and the spectrum observed in the laboratory.

THÉODORE SOLACOLU and DÉMÈTRE CONSTANTINESCO: The modifications undergone by seedlings after remaining a relatively short time in solutions of β-indolyl-acetic acid. β-indolyl-acetic acid is capable of stimulating the plant cell after a short time of contact (15 minutes). The effects last a long time, even if the plant continues to develop in ordinary water.

MLLE. ANNE RAFFY and MAURICE FONTAINE: Determinations of flavin in the course of development in cultures of *Eremothecium Ashbyii*.

ANDRÉ GORIS: The atisine of *Aconitum heterophyllum* and the anthorine of *Aconitum anthora*. Anthorine is identical with atisine (Jowett), and it is suggested that the latter name be retained for the alkaloid.

HENRI BERRIER: Substances of the type of plant auxines in the course of the evolution of *Bombyx mori*.

JEAN ROCHE and RENÉ COMBETTE: The reversibility of the denaturation and coagulation of methæmoglobin.

GUSTAVE GUITTONEAU and MLLE MARIE BEJAMBES: Chromo-resistance and calcium phosphate coating of micro-organisms heated in milk.

RAYMOND HOVASSE: The Zooxanthellæ are dinoflagellates.

CONSTANTIN LEVADITI, ANDRÉ GIRARD, ARON VAISMANN, ANDRÉ RAY and GUY RICHARD: 4-Nitro-4-aminodiphenylsulphoxide and its action in the experimental toxi-infection of mice.

Copenhagen

Royal Danish Academy of Sciences and Letters

October 22.

OTTO NEUGEBAUER: Babylonian theory of eclipses.

November 5.

KNUD JESSEN: Contributions to the late glacial flora of Ireland.

November 19.

NIELS BOHR: Mechanism of nuclear reactions. A discussion of the applications of thermodynamical analogies for the analysis of nuclear reactions.

December 3.

HARALD BOHR and DONALD A. FLANDERS: Algebraic equations with almost periodic coefficients.

December 3.

G. HEVESY and LADISLAV HAHN: Origin of egg phosphorus.

December 3.

G. HEVESY and HILDE LEVI: The artificial radioactivity of hafnium and some other elements.

Moscow

Academy of Sciences (*C.R.*, 16, No. 8, 1937).

V. A. FLORIN: Determination of instantaneous stresses in skeletons of soils.

G. S. LANDSBERG and S. A. UKHOLIN: Frequency of oscillations of the hydroxyl group in methyl alcohol and its dependence on the density.

S. A. UKHOLIN: Dependence of the spectrum of an aqueous compound on the density and the pressure.

V. L. LEVŠIN and S. N. RŽEVKIN: Mechanism of luminescence in liquids under ultra-sonic treatment.

A. T. AKIMOV: Specific electrical resistance of frozen soils.

L. GINDIN and F. ŠEMIAKIN: Linear corrosion of metals. Selective corrosion of iron according to the system water-sulphuric acid-propyl alcohol, at the boundary of three phases.

L. GINDIN, I. I. TORSUJEV and V. A. KAZAKOVA: Relation to metals of sulphur solutions and of a series of organic sulphur compounds in saturated hydrocarbons. The relation to iron of ethyl- and butyl-mercaptan solutions in cyclohexane.

M. I. KNIAGINIČEV and T. M. GORELKINA: New solvents of gluten proteins.

L. A. DREMLIUG: A frost-resistant triple potato hybrid, *Solanum acaule* × *S. tuberosum* (Fürstenkrone) × *S. tuberosum* (*Centifolia*).

M. V. FAVORSKIJ: New fixatives for chromosome morphology.

G. V. GERSHUNI, A. M. ANDREEV and A. A. ARAPOVA: Concerning the cochlear potentials in man.

V. S. SHARDAKOV: Salt resistance of the cotton plant. Localization of salts in the leaf tissues.

Forthcoming Events

[Meeting marked with an asterisk is open to the public.]

Monday, January 10

ROYAL GEOGRAPHICAL SOCIETY, at 8.30.—Eric Shipton: "The Shaksgam Expedition of 1937".

Tuesday, January 11

INSTITUTION OF CIVIL ENGINEERS, at 6.—Sir George Lee: "Recent Engineering Developments in the General Post Office".

Wednesday, January 12

SOCIETY OF GLASS TECHNOLOGY (at the Institution of Electrical Engineers, Savoy Place, Victoria Embankment, London, W.C.2), at 3–9.—Series of public lectures on "Glass in Modern Life".*

Appointments Vacant

APPLICATIONS are invited for the following appointments, on or before the dates mentioned:

JUNIOR MAINTENANCE ENGINEERS (Grade V) at the B.B.C.—The Engineering Establishment Officer, British Broadcasting Corporation, Broadcasting House, London, W.1 (January 15).

TECHNICAL OFFICER at the Air Defence Experimental Station, Biggin Hill, Kent—The Superintendent (January 15).

JUNIOR LECTURER IN SOCIAL STUDIES in the University of the Witwatersrand—The Secretary, Office of the High Commissioner for the Union of South Africa, South Africa House, Trafalgar Square, W.C.2 (January 18).

LECTURER IN BIOLOGY in the Cardiff Technical College—The Director of Education, City Hall, Cardiff (January 19).

SCIENTIFIC ASSISTANT (chiefly biology) to the Metropolitan Water Board—The Clerk of the Board, 173 Rosebery Avenue, London, E.C.1 (January 21).

DEMONSTRATOR IN ENTOMOLOGY in the Liverpool School of Tropical Medicine, Pembroke Place, Liverpool, 3 (January 31).

CAVENDISH PROFESSOR OF PHYSICS in the University of Cambridge—The Vice-Chancellor (February 1).

GEORGE HOLT PROFESSOR OF PATHOLOGY in the University of Liverpool—The Registrar (February 12).

RESEARCH CHEMIST in the British Colliery Owners' Research Laboratory, Royal School of Mines, South Kensington, S.W.7.

ASSISTANT (grade III) in the Aerodynamics Department of the Royal Aircraft Establishment, South Farnborough, Hants—The Chief Superintendent (Quote Ref. No. 641B).

Reports and other Publications

(not included in the monthly Books Supplement)

Great Britain and Ireland

British Empire Cancer Campaign. Fourteenth Annual Report of the General Council, presented at the Meeting held at the House of Lords, 30.11.37. Edited by J. P. Lockhart-Mummery. Pp. xxxiii+247. (London: British Empire Cancer Campaign.) [2611

A Review of Developments in the Applications of Boron in Agriculture and Horticulture, 1935–37. By R. W. G. Dennis. Pp. 15. (London: Boron Agricultural Bureau.) [2611

Report of the Commissioner for the Special Areas in England and Wales for the Year ended September 30. (Cmd. 5595.) Pp. xii+209. 3s. 6d. net. Report of the Commissioner for the Special Areas in Scotland for the period July 7, 1936–August 1937. (Cmd. 5604.) Pp. 76. 1s. 3d. net. (London: H.M. Stationery Office.) [2711

North of Scotland College of Agriculture. Report on the Work of the North of Scotland College for the Year 1936–37. Pp. 43. (Aberdeen: North of Scotland College of Agriculture.) [112

University of Cambridge: Solar Physics Observatory. Twenty-fifth Annual Report of the Director of the Solar Physics Observatory to the Solar Physics Committee, 1936 August 1–1937 July 31. Pp. 4. (Cambridge: Solar Physics Observatory.) [112

Scottish Development Council. Economic Series, No. 14: Scottish Industry. Third Report of the "Oil from Coal" Committee (revised). Pp. 46. (Glasgow: Scottish Development Council.) 6d. net. [612

British Industries Fair, 1938, Olympia and Earls Court, London, February 21st to March 4th. Organized by the Department of Overseas Trade. Special Overseas advance edition. Pp. Ad. xvi+xvi+392+Ad. 104. (London: Department of Overseas Trade.) 1s. [2412

Catalogue of the Twenty-eighth Annual Exhibition of Scientific Instruments and Apparatus, held at the Imperial College of Science and Technology, South Kensington, London, S.W.7. January 4th, 5th and 6th, 1938. Pp. 226. (London: Physical Society.) [3012

Other Countries

Pubblicazioni della Università Cattolica del Sacro Cuore. Serie 4, Scienze biologiche, Vol. 9: Metodi competi e limiti della psicologia nello studio e nella prevenzione della delinquenza. Per Fr. Agostino Gemelli. Seconda edizione. Pp. xvi+147. 12 lire. Serie 6, Scienze biologiche, Vol. 10: Contributi del Laboratorio di psicologia. Per A. Gemelli, H. Rohracher, G. Cossetti, G. Cornelli, G. Zunini. Pp. 261+10 plates. 25 lire. (Milano: Società Editrice "Vita e Pensiero".) [3011

National Research Council of Canada. Bibliography on the Influence of Mineral Deficiencies on Growth and Reproduction of Farm Animals. By Muriel E. Whalley. Pp. 89. (Ottawa: National Research Council.) [2611

Imperial Council of Agricultural Research. Miscellaneous Bulletin No. 15: Selected Clinical Articles (Part 2). Pp. 19+3 plates. (Delhi: Manager of Publications.) 1.4 rupees; 2s. [2611

Smithsonian Miscellaneous Collections. Vol. 91, No. 28: Reports on the Collections obtained by the First Johnson-Smithsonian Deep-Sea Expedition to the Puerto Rican Deep. New Species of Hydroids from the Puerto Rican Region. By C. McLean Fraser. (Publication 3443.) Pp. 7+2 plates. (Washington, D.C.: Smithsonian Institution.) [2711

Union of South Africa: Department of Mines: Geological Survey. Bulletin No. 10: The Chromite Deposits of the Bushveld Igneous Complex, Transvaal. By Dr. W. Kupferbürger and Dr. B. V. Logbaard, in collaboration with Dr. B. Wasserstein and C. M. Schweitzer. Pp. 48+2 plates. (Pretoria: Government Printer.) 6d. [112

Uppsala Universitets Årsskrift, 1935, No. 16: Contributions to the Study of the Theory of Selection. 2: The Problem of Ornithophily. By Douglas Melin. Pp. 355. (Uppsala: A. B. Lundequistska Bokhandeln.) 12.00 kr. [112

Instituto Botanico de la Universidad Central. Estudio botanico-quimico del *Espeletia grandiflora* (Frailejon del paramo del Angel.) By Prof. Acosta Solis and Dr. S. T. Machado. Pp. 62+5 plates. (Quito: Universidad Central.) [112

Herbertia. Vol. 4. Dedicated to the Memory of William Herbert, 1778–1847. Edited by Hamilton P. Traub. Pp. 280. (Orlando, Fla.: American Amaryllis Society.) [112

Report of the Aeronautical Research Institute, Tôkyô Imperial University. No. 156: The Effect of Ground on the Aerodynamic Characteristics of a Monoplane Wing. By Itirô Tani, Masuo Taima and Sôdi Simidu. Pp. 23–76. (Tôkyô: Kôgyô Tosho Kabushiki Kaisha.) 65 sen. [612

Report of the Haffkine Institute for the Year 1936. By Lieut.-Col. S. S. Sokhey. Pp. iii+82. (Bombay: Government Printing and Stationery Office.) 3 annas; 4d. [612

Smithsonian Institution: United States National Museum. Bulletin 166: The Oxystomatous and Allied Crabs of America. By Mary J. Rathbun. Pp. vi+278+86 plates. (Washington, D.C.: Government Printing Office.) 60 cents. [612

University of Sydney. Publications in Geography, No. 4: Land Utilization Regions of Tasmania. By A. G. Lowndes and W. H. Maze. Pp. 29+5 plates. (Sydney: University of Sydney.) 2s. 6d. [612

Victorian Bush Nursing Association. Twenty-Sixth Annual Report and Statement of Accounts to 30th June 1937. Pp. 328. (Melbourne: Victorian Bush Nursing Association.) [612

Union of South Africa: Department of Mines: Geological Survey. Memoir No. 34: The Water-Bearing Properties of the more important Geological Formations in the Union of South Africa. By Dr. H. F. Frommurze. Pp. 186. 5s. Memoir No. 35: The Geology and Archæology of the Vaal River Basin. By P. G. Söhnge, D. J. L. Visser and V. Van Riet Lowe. Pp. 192 (32 plates). 5s. (Pretoria: Government Printer.) [612

National Research Council. Transactions of the American Geophysical Union, Eighteenth Annual Meeting, April 28, 29, 30, 1937, Washington, D.C. Regional Meeting, June 21 to 26, 1937, Denver, Colorado. Part 1: Reports and Papers, Washington, D.C.; General Assembly and Sections of Geodesy, Seismology, Meteorology, Terrestrial Magnetism and Electricity, Oceanography and Volcanology. Pp. 264. 1.75 dollars. Part 2: Reports and Papers, Section of Hydrology and South Continental Divide Snow-Survey Conference. Pp. 265–664. 2.25 dollars. (Washington, D.C.: National Academy of Sciences.) [612

Indian Central Cotton Committee: Technological Laboratory. Technological Bulletin, Series B, No. 22: The Effect of Twist on the Strength and Length of Cotton Fibre. By Harirao Navkal and Dr. Nazir Ahmad. Pp. 34. (Bombay: Indian Central Cotton Committee.) 8 annas. [612

Conseil Permanent International pour l'Exploration de la Mer. Rapports et procès-verbaux des réunions. Vol. 105, 1ère Partie: Procès-verbaux (Juillet 1937). Pp. 57. 3.00 kr. Vol. 105, 2ème Partie: Rapport Administratif (1936–1937). Pp. 80. 3.00 kr. (Copenhague: Andr. Fred. Høst et fils.) [612

Catalogues, etc.

The Phosphate Question. Pp. 8. (London: British Glues and Chemicals, Ltd.)

Sotheran's Price Current of Literature. No. 852: Annotated Catalogue of Works on Medicine, Surgery and Pharmacology. (Medical Series, No. 2.) Pp. 144. (London: Henry Sotheran, Ltd.)

Cambridge Universal Vibrograph for Vertical, Horizontal, Rotational or Spot Vibrations. (Folder No. 62.) Pp. 6. (London: Cambridge Instrument Co., Ltd.)

Calendar for 1938. (Newcastle-on-Tyne: C. A. Parsons and Co., Ltd.).

A Catalogue of Important Books and Periodicals on Geology and Palæontology. (No. 544.) Pp. 38. (London: Bernard Quaritch, Ltd.).